Bull. nat. Hist. Mus. Lond. (Ent.) **71**(2): 135–271 Issued 28 November 2002

A biosystematic revision of the blackflies (Diptera: Simuliidae) of Belize, Central America.

A. J. SHELLEY
Biomedical Sciences Theme, Department of Entomology, The Natural History Museum, London, UK.

L. M. HERNÁNDEZ
Biomedical Sciences Theme, Department of Entomology, The Natural History Museum, London, UK.

M. PENN
Department of Botany, The Natural History Museum, London, UK.

CONTENTS

SYNOPSIS. With the increasing migration of people from Guatemala (where foci of human onchocerciasis exist) to Belize the probability of further introductions of individuals infected with this disease has increased. The present paper provides a comprehensive biosystematic revision of the Simuliidae of Belize, a prerequisite to any future surveys on simuliids if onchocerciasis becomes a public health problem. A key to the adults and pupae of the twelve species collected is provided together with full morphological descriptions of these species, discussions on their taxonomy, and summaries of their distribution and biology. Six new synonyms, a neotype and one lectotype are created. The distribution of Simuliidae in Belize in relation to physical factors is reviewed.

KEY WORDS: Simuliidae, *Simulium*, blackflies, biosystematics, Belize

INTRODUCTION

The Simuliidae of most countries in Central America have been poorly studied, except in Mexico and Guatemala where the presence of foci of human onchocerciasis has stimulated research on their taxonomy and biology (Vargas & Díaz Nájera (1957) for Mexico, Dalmat (1955) for Guatemala). Dalmat 's work in Guatemala has been the most comprehensive for any individual country in Latin America and deals with the biosystematics of the family, its distribution in relation to geology, climate and vegetation, and its medical importance. Nevertheless, there has since been no comprehensive modern taxonomic treatment of the family as a whole in this area and consequently some species still remain only superficially described. Several species were erected on what are now thought to be intraspecific morphological variations and need to be synonymised. This paper provides a modern insight into the species that occur in Belize.

The only previous study carried out in Belize was for a month during the dry season in 1958 (Garnham & Lewis, 1959; Lewis & Garnham, 1960). The objectives were to establish whether human onchocerciasis had dispersed to Belize, especially from foci 300 kms to the west in Guatemala and possibly from Mexico, and to carry out a preliminary survey of simuliids in the northern half of the country at the Mountain Pine Ridge, El Cayo and the Caves Branch-Stann Creek area (Map 1). Although Guatemalans infected with onchocerciasis had been recorded from Belize prior to their survey the absence of recent records of infections led these authors to conclude that either too few infected individuals had been present, or that local anthropophilic simuliid species were inappropriate as vectors for local transmission to have occurred. Of the 13 species of simuliids collected nine were identified and three of these (*S. metallicum s.l.*, *S.haematopotum* [as *S.veracruzanum*] and *S. quadrivittatum*) were collected biting man. They maintained that the risk of onchocerciasis transmission in Belize could only be assessed once the epidemiology of the disease had been better studied in Guatemala and Mexico. Fifty years on we now know that *S. metallicum s.l.* is a vector of onchocerciasis in the Americas and is a species complex of several cytospecies that have different vectorial efficiencies (Shelley, 1988b). *Simulium quadrivittatum* is a secondary vector in Ecuador and *S. gonzalezi* (one of Lewis & Garnham's unidentified species) is a secondary vector in Guatemala. Over the last two decades there have been massive movements of people from Guatemala, Honduras and El Salvador to Belize and they now form 13% of the country's population of 215,500 (Fundación Arias para la Paz y el Progreso Humano, 2000). About 50% are from Guatemala and many enter the country illegally to harvest 'shate' leaves from the palm *Chamaedorea latifolia* in the rain forest area for use in the manufacture of herbal shampoos, and to work in citrus and banana plantations elsewhere. To assess the likelihood of the presence of onchocerciasis transmission in Belize it is necessary to record the species of Simuliidae present and their distribution, sample local human populations for the presence of onchocerciasis as well as immigrants from neighbouring countries such as Guatemala and Mexico where onchocerciasis occurs. Belize has developed considerably with the opening of new roads into the interior and to the southern half of the country since the work of Lewis & Garnham.

This paper provides a biosystematic study of the Simuliidae of Belize with species descriptions for females, males and pupae, identification keys, and species distribution in relation to geology, climate and vegetation. Notes on the basic biology and medical importance of species are given where details are available.

The country of Belize

The maps provided in the following sections are digitised compilations using data from the Government of Belize and personal data of the last author.

Geology

Belize is located on the Caribbean coast of Central America, at approximately 17 degrees north of the Equator within the tropics (Map 1). It is bordered to the north by Mexico and to the south and west by Guatemala. In geographical area Belize is similar to that of Wales and is no more than 270 km north to south and 180 km east to west (Penn, 1995). Belize can be split into three differing geological regions: the north of Belize, the central highland zone (Maya Mountains), and the southern/eastern zones. To the north and east of the Maya Mountains the terrain is quite flat, varying between sea level and no more than 100 m altitude with the eastern regions being mainly dominated by mangrove and swamps. In contrast the Maya Mountains dominate the central part of Belize, running northeast to southwest. To the south of this a relatively flat terrain resumes to the southern border of Belize (Map 2). In more detail (Map 3), the north of Belize is made up of low-lying land, laid down while the surface was a sea floor. During the Cretaceous period (146–65 million years ago) limestone was laid down over much of the lower lying landscape and has since been weathered and re-worked. During the Pliocene (13–3 million years ago), a gradual uplift occurred which today has resulted in a relatively flat ground surface with scattered limestone hills, and a soil structure derived from a sand substratum (Wilson,

1995). In contrast the Maya Mountains (central region) is characterised by a granitic core, and metamorphosed sediments. During the cretaceous period extensive limestone deposits were lain down over all but the highest zones (Bateson & Hall, 1977). Today only isolated limestone features remain visible with a few distinct volcanic intrusions. The Cockscomb Ridge situated in the Cockscomb Reserve is one of the most familiar examples, but other intrusions exist within Mountain Pine Ridge and to the east and south of the Chiquibul National Park. The topography of the central region (Maya Mountains) is characterised by: the underlying geology of Cretaceous limestone; altitudes varying between 500 m and 1200 m; karstic features including large sink holes up to several kilometres in diameter; sparse, steep valleys with rivers and streams, but with most of the drainage being underground. Towards the eastern half of the Maya Mountains, sedimentary mudstones and shales replace the limestone. Here the topography is one of numerous small hills and ridges with moderately steep slopes, and numerous streams and rivers with most of the drainage on the surface. To the south and east of the Maya Mountains, the geology is mainly a mosaic of sand and limestone areas with alluvial deposits.

Climate

Belize has a largely sub-tropical climate with marked wet and dry seasons with an average daily temperature of 26°C. The wet season usually extends from June to December with a brief dry interlude in September, while the dry season extends from January to May. The country experiences brief cool spells during the dry season, when cold fronts ('northerners') pass over Belize, briefly bringing periods of light rain and dips in temperature over the highlands and coastal regions (usual duration 1–2 days). Precipitation across Belize is highly variable and localized, and detailed meteorological data is lacking for vast areas of the country. However, there is a general north to south rainfall gradient, with the south of the country receiving considerably more rainfall than the north (Map 4). While meteorological data are sparse for many regions of Belize, it is widely accepted that the north of Belize receives less than 1500 mm and south of Belize over 4000 mm of rainfall per annum. The Maya Mountains have a substantial influence on the climate of Belize. The topographical heterogeneity of the mountains produces considerable local variations in climatic factors (Penn & Furley, 1998), with heavy localised thunderstorms and rain shadow effects dominating the climate in this region. For example, rainfall in 2001 for the Las Cuevas Research Centre in the Maya Mountains was 1520 mm (Penn 2002, unpublished data), but national figures and maps indicate that this area receives between 2500–3250 mm of rainfall per annum.

Vegetation

The natural vegetation cover of Belize (Map 5) is heavily influenced by the climate, soils, underlying geology and topography. With this in mind a number of researchers have tried to classify and map the vegetation of Belize over the last 80 years (e.g. Iremonger & Brokaw, 1995; Johnson & Chaffey, 1973; Lundel,1937; Penn, M. unpublished data; Wright *et al.*, 1959). Brokaw (1998) describes and reviews the development of vegetation classifications for Belize. As a general guide the vegetation of Belize can be split into six very broad vegetation groups: mangroves and swamps; semi-deciduous tropical forests; evergreen tropical forests; pine savannas; grass savannas; gallery forests.

The geographical spread of each broad vegetation group is as follows: mangroves and swamps dominate the coastal regions, semi-deciduous and evergreen forests dominate the Chiquibul, Cockscomb, Columbia reserves and most of the Maya mountains; the savannas dominate the central lowlands and northern zones where semi-deciduous tropical forests also survive; pine savannas as well as gallery forests exist in Mountain Pine Ridge and in scattered pockets across the north of the country; the far south of the country is dominated by sparse pine and grass savannahs.

This general and simplified broad classification gives a good overview of the Belizean vegetation/land-cover but on its own is not of sufficient detail to reflect the true diversity of the vegetation. On a larger scale Wright *et al.* (1959) have shown that there are 18 main classes of vegetation, with a further 59 subclasses, making a total of 77 different types of vegetation across Belize, with over 13 different types of marshes/swamps and 14 different types of savannas. Similarly, forest classes such as, 'Broadleaf Forests Rich in Lime-Loving Species' have been further subdivided into eight different sub-zones dependent on canopy height and whether they represent seasonal or semi-evergreen forest. More recently Iremonger and Brokaw (1995) have produced a vegetation classification for Belize that is hierarchical in structure, based on physiognomic structure, using Landsat TM data and detailed sampling especially in the north of Belize (Programme For Belize Land). The vegetation zones identified broadly correspond to those of Wright's classification but the authors expanded the classes in some areas and collapsed the older groupings in others, particularly the Chiquibul. Finally, Penn & Sutton (unpublished data) have focused solely on the vegetation of the Chiquibul forest, producing a classification based on the analysis of satellite data and field experience within the region. They have recognized and defined over 24 different forest types, within the Chiquibul forest reserve, ranging from 'Cohune dominated evergreen forests' to 'mahogany and cedar dominated' classes.

MATERIAL AND METHODS

The material from Lewis & Garnham's preliminary survey of simuliids of Belize, housed within the Entomology Department of the BMNH in London, has been used as the starting point for the project. This has been supplemented by material collected during one month's field prospection in all the regions of Belize in the dry season (April/May 2001) (Map 1). Emphasis was placed on the mountainous half of the country south of Belmopan where various vegetation zones occur and hence where species diversity will be far higher and where a large part had not been previously prospected. Rivers draining the western and eastern slopes of the Maya Mountains were sampled using dirt roads south of San Ignacio and the Hummingbird, Stann Creek Valley roads and the Southern Highway for access. Less time was spent sampling simuliids between Belize City and Orange Walk where the land is flatter, drier and consists for the most part of palm savannas and small hills supporting broad leafed deciduous rain forest. Map 1 shows the localities in Belize in relation to rivers and roads where blackflies were collected. In the case of areas in the Maya Mountains watersheds and the upper reaches of the Belize River near San Ignacio almost every site sampled yielded material. Collections for three days in the flatter and drier area around Orange Walk produced no simuliids because the few rivers present were stagnant. The headwaters of the Rio Bravo were not prospected because the landowners refused permission to enter the area.

The techniques for collection, dissection and measurement of specimens are detailed in Shelley *et al.* (1997, 2000). In the description of the pupal gill the appearance of the gill assemblage is described from the dorsal view with the pupa and cocoon lying horizontal on the microscope stage as well as from slide mounted specimens with a lateral view. Specimens have been deposited in the BMNH and voucher specimens of man-biting species in the Las Cuevas Research Station, Belize. Images illustrating the morphology of species were obtained directly from the specimens using a Synoptics composite image analysis system (described in Shelley *et al.*, 2000) and have been stored on CDs in the BMNH. In species where the scutal pattern varies with the direction of the light source two descriptions are given – one for the pattern with the fibre optic light anterior to and on the same level as the specimen and the other with the light source posterior. The specimen is viewed on a dissecting microscope with its body parallel to the stage. Figures 1–14 are provided to orientate the reader on some of the morphology described in the text.

Some of the main problems that we have encountered in this work have been the different interpretations given to variations in coloration, wing venation, morphology of the genitalia and configuration of gill filaments of the pupa by various authors. Descriptions are often based on low numbers of specimens, often with no type status. Our experience of the Neotropical fauna is that only after examination of long series of reared specimens from different localities can a meaningful interpretation of morphological variation be made, and that in the case of apparently polymorphic species reference should be made where possible to type material rather than published figures and descriptions of these specimens. The variation in the artistic abilities of different authors and the interpretation of the orientation of already dissected and mounted parts (especially genitalia) on slides also highlight the importance of this need. Unfortunately, type material has often been lost or the access to certain collections of the Neotropical fauna is not universal. Our use of digital images has at least now removed the artefactual element of illustrating morphological characters. Therefore, our approach in this and previous papers on the Neotropical fauna has been to synonymise names based on minor morphological variations between few specimens, unless good evidence is presented that such variation is specific. Unfortunately, no set of characters can be applied universally – what is an intraspecific variation in one species may be a good specific character elsewhere. Where no convincing evidence for speciation is available our approach has therefore been catholic in that as a rule we regard minor morphological variation as intraspecific e.g. setation in Subcostal and basal section of Radius wing veins, coloration of adult thoraces, abdomens and legs, configuration of gill filaments, distribution of tubercles and trichome branching in pupae, variation in spine number in gonostyles of males. This approach has been used for example in previous treatment of members of the *S.amazonicum* group. Several names were here synonymised with *S.oyapockense* until better descriptions became available to decide species status. This is now beginning to happen with modern, comprehensive morphotaxonomic treatments sometimes linked to cytological and molecular evidence.

The following acronyms are used for depositories of specimens referred to in this paper in the text and under Material Examined.

BMNH	The Natural History Museum, London, U.K.
CUAC	Clemson University Arthropod Collection, Clemson, South Carolina, USA.
DBAT	Dipartimento di Biologia Animale, Universita di Torino, Torino, Italy.
DDSV	Seccion de Onchocercosis, Division de Dermatologia Sanitaria, Ville de Cura, Aragúa State, Venezuela.
INDRE	Instituto Nacional de Diagnóstico y Referencia Epidemiológicos, Mexico City, Mexico [formerly ISET].

IOC	Instituto Oswaldo Cruz, Rio de Janeiro, Brazil.
ISET	Instituto de Salubridad y Enfermedades Tropicales, Mexico City, Mexico.
MCZH	Museum of Comparative Zoology, Harvard, USA.
MNHN	Musée National d'Histoire Naturelle, Paris, France.
NSMT	National Science Museum, Tokyo, Japan.
STMPR	Department of Microbiology, School of Tropical Medicine, San Juan, Puerto Rico.
USNM	United States National Museum, Washington D.C., U.S.A.
ZMHU	Zoologisches Museum der Humboldt-Universität, Berlin, Germany.

Acknowledgements. We thank Mr C. Minty and staff at the Las Cuevas Research Station, Belize for their invaluable support during our field work; Drs R.W. Crosskey of the BMNH and F.C. Thompson of the USNM for valuable discussions during the writing of the paper; Dr.N. Adams of the USNM, Dr P. Adler of CUAC, Drs M. Baylac and J. Charbonnel of the MNHN, Dr M. Maia-Herzog of IOC, Drs. S. Ibáñez Bernal and L. Cervantes, Institute of Ecology, Oaxaca, Mexico, Dr J.A. Juárez, Servicio Nacional de Erradicación de la Malaria, Guatemala City, Dr. C. Martínez of INDRE, Dr B. Merz of the Museum of Natural History, Geneva, Dr P. Perkins of the MCZH, Dr A. Shinohara of the NSMT, Dr H. Takaoka of Oita Medical University, Japan for their assistance in providing type material and other specimens. We are grateful to the Natural History Museum, London for providing the funding for this work.

CHECKLIST OF SIMULIIDAE OF BELIZE

The following twelve species of Simuliidae have been recorded from Belize. They are in alphabetical order for subgenera and for species within each subgenus. There exists a difference of opinion in the definition of the subgenus *Psilopelmia* for the Neotropical region. Coscarón (1987) and Coscarón *et al.* (1993, 1996) removed many of the species previously assigned to *Psilopelmia* to the subgenus *Ectemnaspis*. Thus, *S. ochraceum s.l.* is considered by these authors to be *Ectemnaspis* and Coscarón (1987) placed *S. quadrivittatum* in *Inaequalium*. However, Strieder & Py-Daniel (2000) do not include *S. quadrivittatum* in their revision of the subgenus *Inaequalium*. Therefore, we follow the broader definition of *Psilopelmia* used by Crosskey (1988) and Crosskey & Howard (1996) until such a time when integrated morphological, cytological and molecular studies can be used to revise the subgenus. Peterson (1993) produced a revisionary work on the subgenus *Psilopelmia* for species in the USA, in which a full diagnosis of the subgenus is given.

Simulium (*Hemicnetha*) *earlei* Vargas, Martínez Palacios & Díaz Nájera, 1946
Simulium (*Hemicnetha*) *mexicanum* Bellardi, 1862
Simulium (*Hemicnetha*) *pulverulentum* Knab, 1915
Simulium (*Hemicnetha*) *virgatum* Coquillett, 1902 (complex)
Simulium (*Notolepria*) *gonzalezi* Vargas & Díaz Nájera, 1953
Simulium (*Psaroniocompsa*) *ganaleseuse* Vargas, Martínez Palacios & Díaz Nájera, 1946
Simulium (*Psilopelmia*) *callidum* (Dyar & Shannon, 1927)
Simulium (*Psilopelmia*) *haematopotum* Malloch, 1914
Simulium (*Psilopelmia*) *ochraceum* Walker, 1861 (complex)
Simulium (*Psilopelmia*) *quadrivittatum* Loew, 1862
Simulium (*Psilopelmia*) *samboni* Jennings, 1915
Simulium (*Simulium*) *metallicum* Bellardi, 1859 (complex)

Keys to the Simuliidae of Belize

FEMALES

1. Scutum orange to dark brown 2
– Scutum black 6
2. Gonopophyses small and not protruding from eighth sternite (Fig. 120) 3
– Gonopophyses large and protruding from eighth sternite (Figs. 112, 115) 5
3. Scutum orange with 1+1 white pruinose, sub-median cunae (anterior light source) (Figs. 71, 73) ..... ***ochraceum s.l.***
– Scutum orange to brown with 1+1 white pruinose, sub-median vittae (anterior light source) (Figs. 63, 77) 4
4. Abdominal tergites greyish yellow to green with chequerboard pattern (Fig. 110) ..... ***samboni***
– Abdominal tergites I and II yellowish, III–IX black (Fig. 105) ..... ***callidum***
5. Scutum dark brown with 1+1 large, wedge-shaped, faint greyish white vittae running from anterior margin for two thirds scutal length (anterior light source) (Fig. 39) ..... ***earlei***
– Scutum orange-brown to dark brown with 1+1 dark brown, bowed vittae extending from anterior to posterior scutal margins (anterior light source) (Fig. 45) ..... ***virgatum s.l.***
6. Scutum without pattern 7
– Scutum with pattern 8
7. Small fly (body length in alcohol 1.6–2.2 mm, wing length 1.1–1.7 mm) with setae on scutum scale-like, in groups and with greenish gold reflections (Figs. 57, 58); legs mainly yellow with brown bands (Fig. 91); gonopophyses small and not protruding from eighth sternite (Fig. 116) ..... ***gonzalezi***

– Large fly (body length in alcohol 2.6–3.7 mm, wing length 2.5–2.9 mm) with setae on scutum scale-like, in groups and brass coloured (Figs. 41, 42); legs mainly brown and black with white bands (Fig. 88); gonopophyses large and protruding from eighth sternite (Fig. 113) ..... ***mexicanum***

8. Scutum with greyish or silver vittae covering most of surface 9

– Scutum with silvery white vittae covering up to about 50% of surface 10

9. 1+1 median and 1+1 sub-median metallic grey pruinose vittae (sometimes coalescing posteriorly) covering most of scutum and 1+1 sub-median, highly reflective, greyish blue areas on anterior margin (anterior light source) (Figs. 79, 81, 83); gonopophyses small and not protruding from eighth sternite (Fig. 123) ..... ***metallicum s.l.***

– 1+1 median and 1+1 sub-median, silver grey pruinose vittae covering most of scutum and 1+1 non pruinose black oval areas in sub-median vittae (anterior light source) (Fig. 43); gonopophyses large and protruding from eighth sternite (Fig. 114) ..... ***pulverulentum***

10. Scutum with 1+1 broad, silvery grey vittae running whole length of thorax and absence of black cunae in anterior part of vittae (anterior light source)(Fig. 65); abdomen with distinct, velvet black, median tergal plates (Fig. 106) ..... ***haematopotum***

– Scutum with 1+1 narrow, silvery grey or white vittae running whole length of thorax and presence of black cunae in anterior part of vittae (anterior light source); abdomen black with no velvet black tergal plates (Figs. 104, 109) 11

11. Cunae in silvery white vittae small, triangular and occupying width of narrow anterior portion of vittae, small constriction in vittae at posterior end of cunae (anterior light source)(Fig. 75) ..... ***quadrivittatum***

– Cunae in silvery white vittae large, comma-shaped and not occupying full width of broad anterior portion of vittae, no constriction of vittae anywhere in anterior half (anterior light source) (Fig. 59) ..... ***ganalesense***

MALES

1. Scutum orange to brown 2

– Scutum black 6

2. Scutum orange with 1+1 sub-median, white pruinose cunae running from anterior margin for half length of scutum (light source anterior) (Figs. 176, 180, 184).... 3

– Scutum orange to brown with 1+1 grey or silver pruinose, bowed, sub-median vittae (light source anterior) (Figs. 150, 156) 5

3. Gonostyle sub-rectangular (Fig. 202) ..... ***callidum***

– Gonostyle conical (Figs. 204, 206) 4

4. Gonocoxite almost square, gonostyle about two thirds length of gonocoxite (Fig. 206) ..... ***samboni***

– Gonocoxite rectangular, gonostyle same length as gonocoxite (Fig. 204) ..... ***ochraceum s.l.***

5. Gonostyle with slight enlargement of dorsal and ventral margins (Fig. 188); ventral plate almost square with no keel (Fig. 210) ..... ***earlei***

– Gonostyle with pronounced enlargement of dorsal and ventral margins (Fig. 191); ventral plate rectangular with well developed keel (Fig. 213) ..... ***virgatum s.l.*** brown form

6. Scutum with no pattern 7

– Scutum with pattern 9

7. Gonostyle twice as long as gonocoxite (Fig. 189) ..... ***mexicanum***

– Gonostyle half length of gonocoxite (Fig. 199) 8

8. Scutum velvet black (Figs. 170, 171) ..... ***gonzalezi*** holoptic form

– Scutum greyish black (Fig. 57, 58 [female and male similar]) ..... ***gonzalezi*** dichoptic form

9. Scutum with 1+1 median and 1+1 sub-median, silver cunae on anterior margin (anterior illumination) (Fig. 154) ..... ***pulverulentum***

– Scutum with 1+1 sub-median, silver cunae on anterior margin (anterior illumination) 10

10. Cunae triangular, extending as long tails for two thirds length of scutum (anterior illumination) (Figs.172, 182) 11

Cunae triangular, not extending as long tails (anterior illumination) (Figs. 158, 178, 186) 12

11. Cunae wide and extending to humeri (Fig.172); gonostyle conical (Fig. 200) ..... ***ganalesense***

– Cunae small, not extending to humeri (Fig.182); gonostyle sub-rectangular (Fig. 205) ..... ***quadrivittatum***

12. Cunae narrow and sub-triangular (Fig. 178); gonostyle sub-rectangular half length of gonocoxite (Fig. 203) .... ***haematopotum***

– Cunae broad, triangular (Figs. 158, 186); gonostyles not sub-rectangular, at least twice length of gonocoxite .. 13

13. Gonostyle elongate and conical (Fig. 207); ventral plate with basal arms longer than main body and keel extending for two thirds length of main body (Fig. 228) ..... ***metallicum s.l.***

– Gonostyle elongate with sinuous dorsal and ventral margins (Fig. 192); ventral plate with basal arms as long as main body, keel extending for almost twice length of main body (Fig. 214) ..... ***virgatum s.l.*** black form

PUPAE

1. Gills with six to eight filaments, cocoon slipper or shoe shaped (Figs. 6, 7, 8) 2

– Gills with ten to sixteen filaments, cocoon shoe shaped (Figs.7,8) 10

2. Gills with six filaments 3
– Gills with eight filaments 5
3. Gills with dorsal and median primary branches bifurcating almost at mid point (Fig. 257) ..... *ganalesense*
– Gills with dorsal and median primary branches bifurcating more basally (Figs. 254, 268, 269) 4
4 Gills with thin filaments 3.9–5.2 mm long ..... *metallicum s.l.*
– Gills with thicker filaments 1.1–2.0 mm long ..... *gonzalezi*
5. Cocoon shoe shaped with fenestrations (Figs. 8, 253)... *S. virgatum s.l.* both forms
– Cocoon slipper shaped with no fenestrations (Fig. 6).. 6
6. Gill with most dorsal branches arched upwards from gill trunk 7
– Gill with most dorsal branches arising horizontal to gill trunk 8
7. Ventral primary branch of gill with bifurcation at base of gill (Fig. 259) ..... *callidum*
– Ventral primary branch with bifurcation some distance from base of gill (Fig. 263) ..... *ochraceum s.l.*
8. Gill filaments arranged in a bunch (Figs. 260, 261, 262) ..... *haematopotum*
– Gill filaments arranged in horizontal or vertical plane .. 9
9. Gills arranged in vertical plane, final filament branching at about third length of gill (Fig. 266, 267) ..... *samboni*
– Gills arranged in horizontal plane, final branching at about basal sixth of gill (Figs. 264, 265) ..... *quadrivittatum*
10. Gill with ten filaments with pointed tips (Fig. 252)..... *pulverulentum*
– Gill with 12 or 16 filaments 11
11. Gill with 12 filaments with rounded tips (Fig. 251) ..... *mexicanum*
– Gill with 16 filaments with pointed tips Figs. 249, 250) ..... *earlei*

SPECIES DESCRIPTIONS, DISTRIBUTION AND BIOLOGY

Simulium (*Hemicnetha*) *earlei* Vargas, Martínez Palacios & Díaz Nájera

(Figs. 7, 15, 39, 40, 87, 99, 112, 124, 137, 150, 151, 188, 210, 231, 249, 250).

Simulium (*Dyarella*) *earlei* Vargas *et al.*, 1946: 118–120. HOLOTYPE ♂, MEXICO: Temixco, Morelos, 3.vii. 1945, (*A. Díaz Nájera*) (INDRE) [Examined.]

Simulium (*Hemicnetha*) *earli* [subsequent mispelling by Vargas & Díaz Nájera, 1957: 132.]

Simulium dehnei Field, 1969: 162. HOLOTYPE ♀, PANAMA: Canal Zone, Rodman Naval Base, 25.iii.1955, (*G.Field*) [Future depository cited as USNM, but material now considered lost.] **New synonym.**

Simulium deheni [subsequent mispelling by Coscarón,1987: 35.]

FEMALE. General body colour dark brown. Body length (specimens preserved in alcohol) 3.1–3.4 mm ($\bar{x}$= 3.3 mm, s.d.= 0.14, n=4), wing length 2.5–2.9 mm ($\bar{x}$=2.8 mm, s.d.= 0.23, n=4), wing width 1.2–1.5 mm ($\bar{x}$=1.4 mm, s.d.=0.13, n=4).

Head – dichoptic with dark red eyes and nudiocular area well developed (Fig. 15). Frons, clypeus and occiput black, with silvery grey pruinosity; clypeus covered with pale, semi-recumbent setae and frons with long, erect, black hairs. Mouthparts and maxillary palps dark brown. Antennae with scape and pedicel yellowish brown, rest of flagellar segments black. Cibarium with well developed, sclerotised cornuae and small, irregular teeth in the central trough and internal margins of cornuae (Fig. 27).

Thorax – scutum dark brown with faint white pruinosity and evenly arranged groups of recumbent, whiteish, broadened setae, interspersed with fine black setae; posterior margin with long dark hairs. Scutal pattern varying slightly with illumination. With anterior illumination, thorax dark brown with 1+1 large, greyish white, wedge-shaped vittae beginning on anterior border of scutum and running for two thirds length of scutum; 1+1 blackish, round vittae on anterior margin and area between grey vittae black; humeri and lateral margins silver (Fig. 39). With posterior illumination, thorax dark brown with faint pruinosity and a median longitudinal and 1+1 sub-median posteriorly diverging lines in central region of scutum; posterior margin black (Fig. 40). Scutellum dark brown with recumbent white hairs intermixed with long, black bristles. Postnotum dark brown with silver pruinosity. Pleura brown with silver pruinosity. Costa of wing with sparse distribution of spines and setae. Subcosta with line of setae in distal half. Radius with numerous setae intermixed with distinct spines, basal section of radius bare. Basal tuft of long, dark setae. Leg coloration and proportions as in Fig. 87. Forelegs with coxae, trochanters, femora, and middle of tibiae yellowish to light brown, remainder of tibiae and tarsi dark brown to black. Mid and hind legs mid to dark brown, except for lighter brown on trochanters, base of femora and tibiae, central portion of tibiae and basal half to two thirds of basitarsi and base of tarsal segments II. Claws strongly curved with a distinct basal tooth. Halteres cream with brown base.

Abdomen – tergites I–IX black and brown mottled with very faint overall silver pruinosity, except accentuated on tergite II (Fig. 99). Tergal plates undeveloped in the few specimens examined. Sternites and genitalia dark brown to black. Eighth sternite sclerotised with long, irregularly distributed setae on posterior margin; gonopophyses very long, membranous, narrow apically, with small setae distributed over entire surface (Fig. 112). Cerci sub-rectangular, covered with distinct, long, brown setae; paraproct crescent-shaped, membranous, except on external margin, which is weakly sclerotised, with small triangular process basally; paraproct with prominent brown setae basally and highly setose apically (Fig. 124). Genital fork stout and heavily sclerotised; termination of lateral arms with anterior margin straight and well developed, apically blunt; anterior processes well developed; posterior processes well developed and triangular (Fig. 137). Spermatheca globular, with weak external sculpturing and small groups of spicules on internal surface; area of insertion of spermathecal duct one fifth maximum width of spermatheca.

MALE. General body colour dark brown to black. Body length (specimens preserved in alcohol) 3.1–3.7 mm ($\bar{x}$=3.3 mm, s.d.=0.33, n=3), wing length 2.7–3.7 mm ($\bar{x}$= 2.8 mm, s.d.=0.05, n=3), wing width 0.9–1.4 mm ($\bar{x}$=1.2 mm; s.d.=0.25, n=3).

Head– holoptic with dark red eyes. Rest of head coloration as in female.

Thorax – scutum dark brown with golden, recumbent hairs. Scutal pattern varies slightly with light incidence: with anterior light source thorax brown (Fig. 150). With light source posterior to specimen 1+1 broad, silver vittae beginning near anterior margin and diverging posteriorly, occupying three fourths length of scutum (Fig.151). Humeri, lateral and posterior margins of scutum dark brown to black. Scutellum brown with golden, recumbent hairs and long, erect, dark brown setae. Postnotum brown with silvery grey pruinosity. Wing setation as in female. Leg coloration as in female (Fig. 87).

Abdomen – tergites black, basal fringe with long, brown hairs. Silver pruinose ornamentation as follows: whole of tergite II, tergites III, IV on antero-lateral margins and 1+1 lateral areas on tergites VI and VII. Genitalia black; sternal and tergal plates undeveloped. Gonoxocite sub-quadrangular; gonostyle sub-rectangular with dorsal and ventral margins sinuose, terminating in single, stout spine; gonocoxite and gonostyle covered with long setae (Fig. 188). Ventral plate weakly sclerotised, well developed with long hairs and distinct apical depression in place of keel, spatula-shaped basal arms (Fig. 210). Median sclerite very long, about four times longer than wide at widest point, with small apical incision (appears curled up in all specimens examined) (Fig. 210). Paramere with well-developed and sclerotised basal process and numerous long spines along whole length (Fig. 231).

PUPU. Cocoon length dorsally 3.0–3.7 mm ($\bar{x}$=3.3 mm, s.d=0.24, n=10), ventrally 5.5–5.6 mm ($\bar{x}$=5.5 mm, s.d.=0.37, n=10); pupa length 4.0–4.1 mm ($\bar{x}$=4.1 mm; s.d.=0.40, n=10); gill length 1.3 mm ($\bar{x}$=1.3, s.d.=0.0, n=9).

Cocoon shoe-shaped as in Fig. 7, light to dark brown composed of thick coalesced fibres, with reinforced rim to anterior aperture and central protuberance, margin of aperture weakly to strongly elevated.

Gill light brown with 16 (sometimes 15 or 17) upwardly-directed filaments arranged in bunch in vertical plane. Gill configuration variable with filaments branching basally at different heights (Figs. 249, 250); common pattern as follows: main trunk short, giving rise to two sets of primary branches: the more external consists of 4 primary branches the two most anterior being unbranched and the two more posterior with three and four branches respectively; the internal consists of two primary branches the anterior with three filaments and the posterior with four filaments. Filaments stout, pointed distally, with small spicules on surface, edges crenate; all filaments approximately same length.

Head with 2+2 frontal and 1+1 facial simple trichomes, and 1+1 sub-lateral, simple trichomes between frontal and facial trichomes; frontoclypeus with distinct group of platelets mesally, 1+1 dorso-laterally and 2–3 platelets in groups of 2 or 3 laterally in frontal region, respectively; tubercles absent in frontal region, but rounded and well distributed over entire surface in facial region.

Thorax with 5+5 large, bifid to five-branched trichomes near margin of dorsal cleft and three simple trichomes on alar region; tubercles mostly rounded (few pointed at base of gill), only visible on ventral region, at base of gill and postero-lateral margin of dorsal cleft.

Abdominal tergite I with 2+2 simple, long trichomes laterally and rounded tubercles on posterior margin; tergite II with 3+3 sub-median spines in longitudinal row and 1+1 simple, long setae lateral to outermost spine; tergites III and IV with 4+4 sub-median spines in longitudinal row, sometimes 1+1 simple, short setae anterior to most lateral spines; tergites V–VI with 5+5 small, simple setae in longitudinal row; tergite VII with 1+1 small, simple trichomes sub-laterally; tergite IX without terminal spines, weakly sclerotised. Spine comb distribution as follows: 1+1 groups on antero-lateral margins of tergites II–VII, and on posterior margins of I and II. Sternite III with 3+3 simple, small trichomes and simple hook laterally; sternite IV with 2 sub-lateral and 2 median, small, simple setae, 1+1 simple hooks laterally and spine combs on anterior margin; sternite V with 2+2 close, simple median

hooks, 2 small, simple setae and 1+1 stout teeth laterally, and groups of spine combs on anterior margin; sternites VI–VII with 2+2 well separated hooks, distinct tooth on lateral margin and groups of spine combs on anterior margin, especially laterally; sternite IX weakly sclerotized apically with spine combs on anterior margin.

TAXONOMIC DISCUSSION. *Simulium earlei* was described by Vargas *et al.* (1946) from females, males, pupae and larvae collected at Temixco, in Morelos State, Mexico. Descriptions of all life stages can also be found in Dalmat (1955) and Ibáñez Bernal (1992). We have examined the legs, wing and genitalia of the male holotype and a female paratype both mounted on slides and a pinned male paratype. Our material from Belize was compared to these and found to be conspecific. *Simulium earlei* only shows morphological variation in the number and shape of the trichomes of the frontoclypeus and thorax, and in the configuration and number of pupa gill filaments. All frontal and facial trichomes of the frontoclypeus are generally simple, but sometimes bifid; the sub-lateral trichomes are commonly well separated from the frontal trichomes but in one specimen the sub-lateral trichome of the right side was very close to the frontal trichomes. Ibañez Bernal (1992) reported that the pupa of *S. earlei* has 6+6 trifid, mesal trichomes, but 5+5 bifid to five-branched trichomes were only found in all the specimens examined from Belize. Although the pupa of *S. earlei* typically has 16 gill filaments (Dalmat, 1955; Ibañez Bernal, 1992) specimens with 15 or 17 filaments (sometimes varying with side in the same specimen) were recorded in Belize.

Ibañez Bernal (1992) amended some of the characters given by Vargas *et al.* (1946) in their description of this species. He suggested that females of *S. earlei* are very similar to those of *S. solarii* Stone, *S. guerrerense* Vargas and Díaz Nájera and *S. keenani* Field, the males close to *S. yepocapense* Dalmat and *S. keenani* Field and pupae to the only other Mexican simuliid species with 16 gill filaments, *S. keenani*. He also stated that *S. earlei* and *S. keenani* could be synonyms and the types of *S. keenani* might be lost. We compared specimens of *S. earlei* with the original description of *S. keenani* and agreed with Ibáñez Bernal (1992) that the two species are extremely similar. Males of *S. keenani* cannot be distinguished from males of *S. earlei* based on the form of gonocoxite, gonostyle, paramere or ventral plate nor on the configuration of pupa gill filaments. Females are only separated by the shape of the genital fork, gonapophyses and paraprocts. In *S. keenani* the genital fork is distinctly swollen apically, gonapophyses shorter and sub-triangular, and paraprocts relatively broader apically without a small triangular process basally (see Field, 1969: 158, Figs. 5, 6, 7). In *S. earlei* the genital fork is not swollen apically, gonapophyses are very long and sub-rectangular, and paraprocts relatively narrower apically with a small triangular process basally.

In the key to the pupae of New World *Hemicnetha* (Peterson *et al.*, 1988) *S. earlei*, *S. solarii* and *S. keenani* run to couplet 17 based on a respiratory organ with 15–16 filaments. *Simulium earlei* is then separated from the other two species by having the anterior collar of the cocoon raised well above the level of the dorsum of the pupal thorax, dorso-lateral margins of opening of cocoon curving posteriorly downward in an undulating fashion and the respiratory organ with 16 filaments. We found that these characters vary in all the specimens examined. *Simulium keenani* runs with difficulty to couplet 19, only separated from *S. solarii* by respiratory organs with 16 filaments, variously branching near base, some filaments branching in groups of three, some in pairs and at least three singles, and a longer anterior collar to the cocoon. Similar branching patterns were found in some specimens of *S. earlei*. Based on these morphological differences and the lack of material of *S. keenani* available in this study, we agreed to maintain *S. keenani* and *S. earlei* as separate species until cytological or molecular studies are carried out to assess the identity of these two taxa. Field (1969) stated that the type of *S. keenani* would be deposited in the USNM, but there is no record of this and it is presumably lost (Dr F.C.Thompson, personal communication).

We have studied the description and figures of Field (1969) of his new species *S.delmei* based on a single female taken in a light trap. It is in all respects morphologically identical with *S. earlei* except for a slight difference in setation of the Subcostal vein of the wing, a character known to vary at population level (see *S. ochraceum s.l.*). Of great significance is the triangular, setose and membranous protrusion at the base of the paraproct, which is characteristic of *S. earlei* and hence we synonymise *S. delmei* with *S. earlei* based on their great similarity. There is no record of this type having been deposited in the USNM (Dr F.C.Thompson, personal communication)

DISTRIBUTION. This species was uncommon in Belize, being only found in small numbers in few localities at high altitudes in Mountain Pine Ridge (Table 1, Material Examined, Maps 2, 6) together with *S. pulverulentum* and *S. virgatum s.l.*. *Simulium earlei* has a limited distribution in the Neotropical Region, only occurring in Central America (Mexico, Guatemala and Costa Rica) (Coscarón, 1987; Crosskey and Howard, 1996; Ibáñez Bernal, 1992; Material Examined). Ibáñez-Bernal (1992) reported it occurring between 200–1,700 m in Mexico, while in Guatemala it has been found in the Central and Coastal Departments (Dalmat, 1955).

BIOLOGY AND MEDICAL IMPORTANCE. In Belize females are zoophilic, immature stages being collected in large (10 to 30 m wide), fast flowing rivers, with pupae and larvae attached to rocks and dead leaves in parts of the river where the current is faster. The alimentary habits of the adults of this species elsewhere in this region are unknown (Ibáñez Bernal, 1992).

Simulium (Hemicnetha) mexicanum Bellardi

(Figs. 7, 16, 28, 41, 42, 88, 100, 113, 125, 138, 152, 153, 189, 211, 251).

Simulium mexicanum Bellardi, 1862 (appendix to part 2): 6. LECTOTYPE ♀, MEXICO: Veracruz State, Tuxpango, near Orizaba [collection date and collector unknown] (DBAT). [Examined.] [Lectotype designation in Shelley *et al.*, 1989].

Simulium aureopunctatum Malloch, 1914: 27. HOLOTYPE ♀. GUATEMALA: Livingston (6.v. or 5.vi. year not given) (*Barber & Schwarz*) (USNM, cat. no. 15406). [Examined.] [Synonymy by Bequaert 1934: 208.]

Simulium placidum Knab, 1915: 281. HOLOTYPE ♀, TRINIDAD: Arima river, 31.xii.1913 (*F. W.Urich*) (BMNH) [Examined.] [Synonymy by Vargas & Díaz Nájera, 1951: 133.]

Simulium lugubre Lutz & *Nuñez Továr* in Lutz, 1928: 46. SYNTYPES ♀, ♂, VENEZUELA: Aragua, Rio de Maracay, La Trinidad, 28.xiii.1915 (*A. Lutz & Nuñez Továr*) (IOC). [Examined.]. [Synonymy by Fairchild, 1940:708.]

Simulium turgidum Hoffmann, 1930b: 298. SYNTYPES ♀, MEXICO: Chiapas State, Soconusco District, Finca Santa Anita; vii.1930, (collector and depository unknown). [Synonymy by Bequaert, 1934: 208.]

Simulium bellardii Py-Daniel & Moreira Sampaio, 1994:149. [Unnecessary replacement name proposed by these authors on upgrading the subgenus *Hemicnetha* to genus – see Crosskey & Howard, 1996: 85.]

FEMALE. General body colour black. Body length (specimens preserved in alcohol) 2.6–3.7 mm ($\bar{x}$=3.1 mm, s.d.=0.35, n=7), wing length 2.5–2.9 mm ($\bar{x}$=2.7 mm, s.d.=0.15, n=7), wing width 1.3–1.5 mm ($\bar{x}$=1.3 mm, s.d.=0.14, n=7).

Head – dichoptic with red eyes; nudiocular area well developed (Fig. 16). Frons, clypeus and occiput black with grey pruinosity, covered in numerous black bristles that are longer and denser on upper margin of clypeus and occiput. Proboscis light brown, maxillary palps black. Antennae dark brown with scape, pedicel and first flagellomere orange. Cibarium with large, unarmed central trough, cornuae well developed and sclerotised (Fig. 28).

Thorax – Scutum, humeri and paranotal folds black with grey pruinosity irrespective of light direction (Figs. 41, 42). Scutum with numerous, adpressed, short, black setae becoming longer and upright on posterior border, interspersed with clumps of adpressed, brass-coloured, scale-like setae. Pleural region dark brown with grey pruinosity. Scutellum dark brown to black with grey pruinosity and with scattered, upright, black bristles on whole surface except anterior border and brass-coloured, adpressed, scale-like setae over whole surface. Postnotum black with grey pruinosity. Subcostal wing vein with irregular row of setae over entire length; basal section of R with three irregular rows of setae along entire length. Costal base tuft of dark brown setae. Fore legs with coxae, trochanters, and femora light brown, tibiae white pruinose with apical third and inner margin black, tarsi black. Mid leg coxae dark brown with grey pruinosity, trochanters and femora black, tibiae black with up to basal third light brown, basal two-thirds of basitarsus light brown, rest black, other tarsal segments black. Hind leg coxae dark brown with grey pruinosty, trochanters light brown, femora black, basal third of tibiae white merging to black on apical two-thirds, basal half of basitarsi white distal half black, rest of tarsi black. Colour and proportions of legs as in Fig. 88. Claws curved with basal tooth. Halteres white with black stems.

Abdomen – tergite I velvet-black with long, brass-coloured basal fringe, tergite II mottled brown and black with grey pruinosity, tergites III–V velvet black, tergites VI–IX shiny black (Fig. 100). Tergal plates highly sclerotised especially on tergite II. Sternites I and II light brown, rest black. Genitalia black. Eighth sternite well scelerotized with 4–6 setae on each side; gonopophyses well developed, sub-triangular, totally membranous and covered with fine setae (Fig. 113). Cerci hemispherical; paraprocts large and sub-quadrangular with long bristles and short thick setae (Fig. 125). Genital fork short, strongly sclerotised and with highly developed lateral arms and anterior processes (Fig. 138). Spermatheca oval, strongly sclerotised with no external sculpturing and spicules on inner surface randomly distributed; width of membranous area of insertion of spermathecal duct large, about half maximum width of spermatheca.

MALE. General body colour black. Body length (specimens preserved in alcohol) 3.3–3.7 mm ($\bar{x}$= 3.5, s.d.=0.14, n=5), wing length 2.6–3.1 mm ($\bar{x}$=2.8, s.d.=0.21, n=5), wing width 1.2–1.5 mm ($\bar{x}$=1.4 mm, s.d.=0.10, n=5).

Head – holoptic with red eyes. Clypeus black with grey pruinosity. Rest of head coloration as in female.

Thorax – coloration and setation of scutum, humeri, paranotal folds, pleural region, scutellum and postnotum as in female, except scale-like setae golden and thin dark median line running whole length of

scutum, free of these scales (Figs. 152, 153). Subcostal wing vein and basal section of Radius bare. Leg coloration and form as in female, except white area of hind tibia reduced to point of articulation with femur. Halteres as in female.

Abdomen – tergite I velvet-black with basal tuft of long black hairs. Tergites II–IX velvet-black with the following silver pruinose ornamentation: tergite II covering whole segment, tergite IV covering anterior border, except for median portion, tergites V–VII completely covered except for median triangle on posterior border of each tergite; tergite VIII with small lateral area on anterior margin. Sternites mottled brown and black with poorly developed sternal plates. Genitalia velvet-black. Gonocoxite rectangular, wider than long, gonostyle elongate with weakly developed sub-terminal spine (Fig.189). Ventral plate rectangular with sclerotised, poorly developed basal arms and large keel; ventral plate densely covered with fine setae and small spines (Fig. 211). Median sclerite elongate with apical depression (Fig. 211). Paramere (Fig. 232) with enlarged basal process and few stout spines apically.

PUPA. Cocoon length dorsally 2.8–3.8 mm ($\bar{x}$=3.2 mm, s.d.=0.24, n=12), ventrally 3.5–5.4 mm ($\bar{x}$=4.4, s.d.=0.52, n=12); pupa length 4.1–5.4 mm ($\bar{x}$=4.7 mm, s.d.=0.46, n=10); gill length 1.2–1.9 mm ($\bar{x}$=1.6, s.d.=0.17, n=12).

Cocoon shoe-shaped (Fig. 7), mid brown; rim of aperture mid brown, reinforced and without fenestrations as seen in *S. virgatum s.l.*. Cocoon surface of thin, amorphous, translucent, elastic substance in which thick, interwoven fibres are sometimes visible.

Gill light to dark brown, generally protruding beyond collar of cocoon, with 12 short, forwardly-directed filaments arranged in a bunch. Main trunk of gill giving rise to an inner primary branch bearing five filaments and an outer branch with seven filaments. Filaments arise basally on gill (Fig. 251), are slender with crenate margins and rounded distally, their surfaces covered with fine spicules.

Head with 2+2 frontal and 1+1 facial trichomes, all poorly developed and unbranched; surface of head with platelets, which in frontal region are scattered, enlarged and highly sclerotised and in facial region are dense and of normal size, and usually with scattered, rounded tubercles.

Thorax with 5+5 antero-dorsal, poorly developed, unbranched trichomes. Surface of anterior region of thorax covered in well developed highly sclerotised tubercles, which usually extend to posterior border of thorax either side of raphe and in pair of sub-median and lateral bands to posterior thoracic border which is densely covered by normal size tubercles. Ventral surface of thorax without tubercles.

Abdominal tergite II with 3+3 well developed simple hooks and 1+1 simple fine hairs external to these; III–IV with 4+4 simple hooks; IX with no spines; II–IX with 1+1 well-developed areas of spine combs on anterior margins and I and II with groups of spine combs on posterior margins. Sternite IV with no hooks or hairs; V–VII with 2+2 simple hooks; I+I patches of spine combs on anterior borders of sternites IV–VIII.

TAXONOMIC DISCUSSION. Shelley *et al.* (1989) discussed all the synonyms of *S. mexicanum*, their type depositaries and noted that Bellardi had apparently confused the sex of his type specimen. *Simulium mexicanum* shows little morphological variation given its wide distribution; only the branch height of pupal gills, though basal, can vary within populations in Ecuador. In Belize, variation in the tubercles of the male pupa frontoclypeus and thorax occurs. The tubercles may be lightly to densely distributed over the surface of the frontoclypeus. In the thorax they are generally arranged in 1+1 sub-median and 1+1 lateral discrete bands running from the anterior border to the mid point of the thorax or in some cases may cover the entire thoracic surface. *Simulium mexicanum* is closely related to *S. smarti* Vargas, although females superficially resemble *S. gnianense* Wise and *S. orbitale* Lutz in coloration (Shelley *et al.*, 1989).

DISTRIBUTION. This species was relatively common in Belize in areas over 300 m at Mountain Pine Ridge, although it was collected at one locality below 50 m (Table 1, Material Examined, Maps 2, 7). It was found sympatrically with other species of the subgenus *Hemicnetha* (*pulverulentum* and *virgatum*) as well as with *S. callidum*, *S. gonzalezi* and *S. samboni*. It has also been recorded from Bolivia, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Panama, Tobago, Trinidad and Venezuela (Crosskey, 2002; Crosskey & Howard, 1996; Shelley *et al.* (1989).

BIOLOGY AND MEDICAL IMPORTANCE. In Belize *S. mexicanum* showed the same biological characteristics as elsewhere in Latin America (Shelley *et al.*, 1989). It is a zoophilic species often breeding in enormous numbers, in small, fast flowing streams at both low and high altitudes usually in, or in close proximity to, waterfalls. It has been reported to bite man occasionally in Colombia, Ecuador and Venezuela. In Trinidad it bites mules and donkeys. *Simulium mexicanum and S. metallicum s.l.* were originally thought to be associated with the regular transmission of Venezuelan Equine Encephalitis in Colombia, but recent evidence suggests that at most they only occasionally transmit the virus mechanically Homan *et al.* (1985). In Guatemala it bites horses, mules, cattle, sheep, goats, pigs, dogs, chickens (Dalmat, 1955).

Simulium (*Hemicnetha*) *pulverulentum* Knab

(Figs. 7, 17, 29, 43, 44, 89, 101, 114, 126, 139, 154, 155, 190, 212, 233, 252).

Simulium pulverulentum Knab, 1915:177. HOLOTYPE ♀, BELIZE [as British Honduras]: Stann Creek District, Punta Gorda, [No collection date] (*J.D.Norton*) (USNM, cat. no. 19111).

FEMALE. General body colour black. Body length (pinned specimens) 1.9–3.4 mm ($\bar{x}$=2.3 mm, s.d.=0.45, n=10), wing length 2.0–2.9 mm ($\bar{x}$=2.4 mm, s.d.=0.27, n=10), wing width 0.5–1.1 mm ($\bar{x}$= 1.0 mm, s.d.=0.17, n=10).

Head – dichoptic with red eyes; nudiocular area well developed (Fig. 17). Frons, clypeus and occiput black with grey pruinosity, covered in numerous fine golden hairs that are denser on margins. Proboscis and maxillary palps dark brown. Antennae dark brown with scape and pedicel orange. Cibarium with margin of central trough and well-developed cornuae sclerotised. Central trough with several rows of small, mainly blunt but some sharp teeth, which extend on margin of trough to base of cornuae (Fig. 29).

Thorax – black (but fading to dark brown in old specimens) with grey pruinose pattern that varies with direction of light source. With light source anterior most of scutum grey pruinose with median black line, 1+1 narrow, curved sub-median vittae beginning in anterior fourth of scutum and extending to posterior margin, 1+1 black ovoid areas lateral to anterior parts of vittae (Fig. 43). Lateral and posterior margins black and paranotal folds and a circular area posterior to these velvet black. With posterior light source scutum greyish black with 1+1 sub-median grey pruinose triangular areas joined at anterior scutal margin (Fig. 44). Scutum with numerous, adpressed, short, golden setae. Pleural region black with grey pruinosity. Scutellum dark brown with dense covering of fine, long brass-coloured hairs. Postnotum black with grey pruinosity. Subcostal wing vein bare or with 1–4 setae in middle part; basal section of Radius bare. Costal base tuft of dark brown setae. Fore leg coxae and trochanters light brown, coxae with grey pruinosity, femora and tibiae mottled light and dark brown with basal articulation of tibia cream, tarsi brownish black. Mid and hind leg coxae dark brown with grey pruinosity, trochanters mottled, light brown, femora dark brown with basal articulation cream, tibiae dark brown to black with basal articulation and a ring in basal quarter cream, basal two-thirds of basitarsi cream, rest dark brown to black, other tarsal segments black with articulation of second tarsal segment cream. Colour and proportions of legs as in Fig. 89. Claws curved with large basal tooth. Halteres white with black stems.

Abdomen – tergite I dark brown with light brown central portion and long, brass-coloured basal fringe; tergite II dark brown with light brown central portion; tergites III–V velvet black, tergites VI–IX shiny black (Fig. 101). Tergal plates highly sclerotised. Sternites and genitalia black. Eighth sternite well scelerotized with 1+1 groups of about 16 medium size setae; gonopophyses well-developed, triangular, totally membranous except for inner sclerotised margin and covered with fine setae (Fig. 114). Cerci hemispherical and sclerotised; paraprocts large, membranous and subquadrangular covered with long and short setae (Fig. 126). Genital fork short, strongly sclerotised and with highly developed lateral arms and anterior processes (Fig. 139). Spermatheca oval, strongly sclerotised with no external sculpturing and spicules on inner surface randomly distributed; width of membranous area of insertion of spermathecal duct large, about half maximum width of spermatheca.

MALE. General body colour black. Body length (specimens preserved in alcohol) 2.6–3.7 mm ($\bar{x}$=3.2 mm, s.d.=0.35, n=19), wing length 1.7–2.7 mm ($\bar{x}$=2.1 mm, s.d.=0.26, n=19), wing width 0.7–1.5 mm ($\bar{x}$=1.0 mm, s.d.=0.22, n=19).

Head – holoptic with red eyes. Rest of head as in female but less setose.

Thorax – with anterior light source scutum dark black with 1+1 small, grey pruinose median cunae that coalesce and 1+1 sub-median, smaller cunae lateral to these on anterior margin (Fig. 154). With light source posterior 1+1 grey pruinose posteriorly diverging median bands in place of median cunae seen with anterior light source (Fig. 155). Scutum with dense covering of short, adpressed, golden setae. Scutellum dark black with short, adpressed, golden setae and long dark setae on posterior margin, postnotum dark black with grey pruinosity. Pleural region as in female. Subcostal wing vein and basal section of Radius bare. Leg coloration as in female, except basal half of mid and hind basitarsi cream and rings on mid and hind tibiae not so apparent (Fig. 89). Halteres as in female.

Abdomen – tergite I velvet-black with basal tuft of long yellowish hairs. Tergites II–IX velvet black with following silver pruinose ornamentation: tergite II covering whole segment, all of tergite VI except central part of segment, VII–VIII with small lateral areas. Sternites mottled brown and black with poorly developed sternal plates. Genitalia black. Gonocoxite sub-rectangular, wider than long, gonostyle large, elongate with weakly developed terminal spine [Dalmat, 1955 records two spines] (Fig.190). Ventral plate rectangular with sclerotised, poorly developed basal arms and large keel forming tube; ventral plate densely covered with fine setae and small spines (Fig. 212). Median sclerite sub-rectangular (Fig. 212). Paramere (Fig. 233) with enlarged base plate and numerous, similarly sized spines with convex sides.

PUPA. Cocoon length dorsally (specimens in alcohol or glycerine) 1.9–3.3 mm (x̄=2.8 mm, s.d.=0.31, n=29), ventrally 2.9–5.5 mm (x̄=3.8 mm, s.d.=0.51, n=30); pupa length 2.5–4.1 mm (x̄=3.3 mm, s.d.=0.37, n=30); gill length 0.6–1.3 mm (x̄=0.9 mm, s.d.=0.16, n=30).

Cocoon shoe-shaped as in Fig. 7, mid brown; rim of aperture mid brown, reinforced and without fenestrations as seen in *S. virgatum s.l.*. Cocoon surface of thin, amorphous, translucent, elastic substance in which thick, interwoven fibres are sometimes visible.

Gill light to dark brown, generally protruding beyond collar of cocoon, with ten short, forwardly-directed filaments arranged in a bunch. Main trunk of gill giving rise to a ventral primary branch, which immediately bifurcates and a dorsal primary branch, which bifurcates basally to form an inner and outer secondary branch each with four filaments. Filaments arise basally on gill, are slender with crenate margins and rounded distally, their surfaces covered with fine spicules and their apices pointed (Fig. 252).

Head with 2+2 frontal and 1+1 facial trichomes, all poorly developed and unbranched; surface of head with some platelets and no tubercles; patch of small tubercles in area of facial trichomes.

Thorax with 5+5 poorly developed, unbranched trichomes in anterior half. Thorax without tubercles except in a band either side of dorsal raphe, in a patch ventrally below gill and posteriorly or with surface of anterior region covered in well developed highly sclerotised tubercles, which usually extend to posterior border of thorax either side of raphe and in pair of sub-median and lateral bands to posterior thoracic border which is densely covered by normal size tubercles.

Abdominal tergite I with 2+2 sub-median, simple setae; tergite II with 3+3 well developed simple hooks and 3+3 fine setae anterior to these, one between the outer two and the others being these and lateral margin; III–IV with 4+4 simple hooks; IX with no spines; II–IX with 1+1 well-developed areas of spine combs in sub-median to lateral position on anterior margins. Sternite IV with no hooks or hairs; V–VII with 2+2 simple hooks; I+I patches of spine combs on anterior borders of sternites IV–VIII and over most of sternite IX.

TAXONOMIC DISCUSSION. This species was described in the female from a series of 35 specimens collected at Punta Gorda in southern Belize. A holotype was selected and deposited in the USNM and two paratypes were sent to the BMNH. The latter specimens correspond to the material collected from Belize on which the above description was based. Full descriptions of this species are given by Dalmat (1955) from specimens collected in Guatemala and Fairchild (1940) with material from Panama. Vargas & Díaz Nájera (1957) provided full descriptions and figures for the Mexican species of *Hemicnetha* as did Ibáñez Bernal (1992) in his revision of the Mexican species of this subgenus, as well as providing a list of previous descriptions of *S. pulverulentum*. *Simulium pulverulentum* is similar to *S. guerrerense* described by Vargas & Díaz Nájera (1956). The first of these authors had previously included the latter species in a previous description of *S. pulverulentum*, but then distinguished the two species by the form of the ventral plate in the male. The differences cited for the female – in the genital fork, pilosity of the Subcostal vein in the wing and in the eighth sternite are here regarded as intraspecific variations, but differences in the size of the nudiocular triangle are probably interspecific. Their characters for separating pupae are, as they themselves note, imprecise. Ibáñez Bernal (1992) recorded the absence of spines on sternite V of the pupa of *S. pulverulentum* as diagnostic for this species compared to other *Hemicnetha* species in the area. The figure of the gill of *S. guerrerense* in the latter author's work shows the gill tips as rounded, whereas Vargas & Díaz Nájera (1956) figure them as pointed as in *S. pulverulentum*. Peterson *et al.*, 1988 in their key to pupae of species of New World *Hemicnetha* separated *S. guerrerense* (from Mexico) from *S. pulverulentum* (from Belize, Guatemala, Mexico, Panama, El Salvador and Venezuela) on differences in the inclination of the cocoon aperture and the shorter gill of the latter species. They based their comparison on specimens of *S. pulverulentum* that they had examined and figures and the key of Vargas & Díaz Nájera (1957) for *S. guerrerense*, citing figures from the latter paper for both these species in their key. We can see no difference in gill length between the two species figured by Vargas & Díaz Nájera (1957) and are not convinced by the minor difference in cocoon aperture, which could be artefactual or an intraspecific variation. Also this is contrary to the observations of other authors. Dalmat (1955) recorded a maximum gill length of 0.9 mm on material that appears to be *S. pulverulentum* judging by the ventral plate; our specimens from Belize measured 0.6–1.3 mm; Lewis's material in the BMNH from northern Venezuela (1963) shows gill lengths varying from 1.0–1.4 mm (x̄=1.1 mm, s.d.=0.09, n=15) and Ramírez Pérez (1983) recorded the length as 1.1 mm in specimens from the same area. Vargas & Díaz Nájera (1956) recorded the maximum gill length for *S. guerrerense* as 1 mm. A closer study of these species linking DNA and chromosomal variation to morphological differences is required in order to establish the status of *S. guerrerense*.

DISTRIBUTION. *Simulium pulverulentum* was a relatively common species in more mountainous areas of Belize (Table 1, Material Examined, Maps 2, 8), being found sympatrically with other species of *Hemicnetha* and *S. callidum*, *S. gouzalezi*, *S. haematopotum*, *S. metallicum* and *S. samboni*.

Elsewhere it occurs in Colombia, Guatemala, Honduras, Mexico, Nicaragua, Panama, El Salvador and Venezuela (Crosskey & Howard, 1996; Dalmat, 1955; Ibáñez Bernal, 1992; Material Examined). Crosskey & Howard (1996) include Guyana based on the record in Vulcano (1981). We consider it unlikely that this species occurs in Guyana because it was not recorded there by Smart (1940), is not present in southern Venezuela contiguous with Guyana (Ramírez Pérez, 1983) nor in the contiguous eastern Roraima State in northern Brazil (Dr M. Maia-Herzog, personal communication).

BIOLOGY AND MEDICAL IMPORTANCE. In Belize *S. pulverulentum* was collected in large (5 to 30 m wide) and fast flowing rivers, with pupae and larvae attached to fallen leaves, submerged vegetation and rocks in parts of the river where the current is faster. It was zoophilic. In Central America it is found from sea level to 1600 m and larvae breed in rivers up to 25 m wide (Ibáñez Bernal, 1992). In Guatemala it bites horses, mules and cattle (Dalmat, 1955) and in Mexico is of veterinary importance because it feeds on horses and cattle (Ibáñez Bernal, 1992).

Simulium (*Hemicnetha*) *virgatum* Coquillett (complex)

(Figs. 8, 18, 30, 45, 46, 90, 102, 115, 127, 140, 156, 157, 158, 159, 191, 192, 213, 214, 234, 235, 253).

Simulium (*Hemicnetha*) *virgatum* Coquillett, 1902: 97. HOLOTYPE ♂, USA: New Mexico, Las Vegas Hot Springs, 4. viii. (*H.S.Barber*) (USNM, cat. no. 6183). [Examined.]

Simulium cinereum Bellardi, 1859: 13. SYNTYPES ♀♂, MEXICO: Morelia. [collection date not specified] (*Henri de Saussure*) (DBAT?) [Preoccupied.]

Simulium tephrodes Speiser, 1904: 148. [Replacement name for *S. cinereum* Bellardi.]

Simulium hippovorum Malloch, 1914: 29. HOLOTYPE ♀, MEXICO: Sierra Madre, Head of River Piedras Verdes, [July 27] (*C.H.T.Townsend*) (USNM, cat. no.15407). [Synonymy by Dyar & Shannon, 1927.]

Simulium rubicundulum Knab, 1915: 178. HOLOTYPE ♀, MEXICO: Córdoba, 17.xii.1907 (*F.Knab*) (USNM, cat. no. 19112). [Synonymy by Dyar & Shannon, 1927.] [Examined.]

Simulium chiapanense Hoffmann, 1930b: 293. SYNTYPE ♀♀, MEXICO: Chiapas State, Soconusco District, Finca Santa Anita, vii. 1930 (*C.C.Hoffmann*) [Type depository not cited, specimens numbered as 18006.] [Synonymy by Dampf in Bequaert, 1934.]

Simulium chiapense Stone, 1948: 400. [Incorrect subsequent spelling of *S. chiapanense* Hoffmann.]

The descriptions are based on the material collected from Belize. They have been provisionally identified under the name *S. virgatum sensu lato* until the confusion surrounding *S. virgatum sensu stricto* and its near relatives is clarified. Morphological variations seen in specimens in the BMNH collection under this name and in the closely related species *S. paynei* (and its synonyms *S. acatenangoense* and *S.mathesoni*) and *S. rubrithorax* as well as loaned type material of *S. rubicundulum*) (a synonym of *S.virgatum s.s.*) are summarised in Tables 2, 3 and reviewed in the Taxonomic Discussion.

FEMALE. General body colour brown. Body length (pinned specimens) 3.6–3.9 mm ($\bar{x}$=3.7 mm, s.d.=0.15, n=3), body length (specimen in spirit) 4.0 mm, wing length 3.0–3.7 mm ($\bar{x}$=3.4 mm, s.d.=0.28, n=4), wing width 1.2–1.7 mm ($\bar{x}$=1.5 mm, s.d.=0.19, n=3).

Head – dichoptic with red eyes; nudiocular area well developed (Fig. 18). Frons, clypeus and occiput black with grey pruinosity, covered in numerous black bristles that are longer and denser on frons and occiput. Proboscis and maxillary palps black. Antennae dark brownish black with scape and pedicel light orange. Cibarium with large, central trough, with irregular rows of minuscule fine teeth on margin, cornuae well developed and sclerotised (Fig. 30).

Thorax – scutal pattern formed by areas of pruinosity and varying with position of light source. With light source anterior scutum mid brown (sometimes brown with black mottling) and anterior, lateral and posterior margins brownish black with greyish pruinosity. Scutum divided by median black line and 1+1 submedian, dark brown, bowed vittae extending from anterior to posterior margins (Fig.45). With posterior light source main area of scutum without pruinosity and mid-brown to greyish-brown and vittae become greyish white pruinose (Fig.46). Scutum covered with dense vestiture of recumbent short hairs varying from brass coloured to black depending on light direction. Paranotal fold greyish black pruinose. Pleural region greyish black with dark brown mottling and grey pruinosity. Scutellum dark brown to black with grey pruinosity and with scattered, upright, black bristles on whole surface except anterior border and brass-coloured, adpressed, widened setae over whole surface. Postnotum dark brown or black with grey pruinosity. Subcostal wing vein with single row of 9–19 setae along basal two thirds (sometimes with one separate from rest in distal third); basal section of Radius bare. Costal base tuft of dark brown setae. Legs cream with the following dark brownish black bands: fore leg distal articulation of femora, incomplete band in basal third and distal third of tibiae, all of tarsi; mid and hind legs as fore legs except coxae and only distal half of basitarsi black and sometimes distal half of hind leg femora black (Fig. 90). Claws curved with well developed basal tooth. Halteres white with black stems.

Abdomen – tergite I velvet black and brown mottled

with long, brass-coloured basal fringe, tergite II mottled velvet brown and black with slight grey pruinosity, tergites III–V velvet black, tergites VI–IX shiny black (Fig. 102). Tergal plates highly sclerotised. Sternites and genitalia black with brown mottling. Eighth sternite well scelerotized with 6–7 setae on each side; gonopophyses well developed, triangular, totally membranous and covered with fine setae (Fig. 115). Cerci hemispherical and sclerotised; paraprocts large and sub-quadrangular with antero-dorsal patch of dark sclerotisation, long bristles and short thick setae (Fig. 127). Genital fork strongly sclerotised, well developed knob at end of shaft and with highly developed lateral arms with prominent anterior and posterior processes (Fig. 140). Spermatheca oval, strongly sclerotised with no external sculpturing and spicules on inner surface randomly distributed; width of membranous area of insertion of spermathecal duct large, about a third maximum width of spermatheca.

MALE. General body colour brown. Body length (pinned specimens) 3.0–3.9 mm ($\bar{x}$=3.5 mm, s.d.=0.34, n=6), (specimens in spirit) 4.1–4.4 mm ($\bar{x}$=2.8 mm, s.d.= 0.35, n=4), wing length 2.0–3.6 mm ($\bar{x}$=2.8 mm, s.d.=0.35, n=12), wing width 1.2–1.7 mm ($\bar{x}$=1.4 mm, s.d.=0.13, n=12). Black form – body length (pinned specimen) 3.3 mm, wing length 3.0 mm, wing width 1.4 mm.

Head – holoptic with red eyes. Clypeus brownish black with grey pruinosity. Rest of head coloration as in female.

Thorax – orange to dark mottled brown – scutum with light source anterior similar to female except bowed sub-median vittae greyish pruinose (Fig. 156). With light source posterior to specimen 1+1 sub-median, white, pruinose commas slightly posterior to anterior border and white, pruinose humeri (Fig. 157), which may extend to posterior margin. Rest of coloration and setation of scutum, humeri, paranotal folds, pleural region, scutellum and postnotum as in female. A black male was collected (Figs. 158, 159), which showed a scutal pattern very similar in colour and form to the *S. virgatum* holotype (Figs. 160, 161). The scutellum of this specimen was dark brown and the postnotum black. Subcostal wing vein bare (one specimen with single seta in middle of vein); basal section of Radius bare. Leg coloration as in female (Fig. 90). Halteres as in female.

Abdomen – tergite I mottled, velvet brown and black with basal tuft of long black hairs. Tergites II–IX velvet-black with the following silver pruinose ornamentation: tergite II covering whole segment except for median area on posterior border, tergites III and IV with 1+1 sub-median large spots, tergites V–VI completely covered except for median part and posterior border of tergite V and posterior margin of tergite VI. Sternites and genitalia brownish black with well developed sternal plates. Gonocoxite rectangular, wider than long, gonostyle elongate with sinuous edges and well developed sub-terminal spine (Fig. 191). Ventral plate rectangular with sclerotised, well developed, short basal arms and large keel; ventral plate densely covered with fine setae and small spines (Fig. 213). Median sclerite ovoid with apical depression (Fig. 213). Paramere (Fig. 234) with enlarged basal process and many fusiform stout spines.The genitalia of the single black specimen were dissected and mounted on a slide. There were no differences in morphology between the normal brown and the black forms (Figs.192, 214, 235).

PUPA. Cocoon length dorsally (specimens in alcohol or glycerine) 4.0–5.4 mm ($\bar{x}$=4.8 mm, s.d.=0.4, n=18), ventrally 4.9–8.2 mm ($\bar{x}$=6.1 mm, s.d.=0.9, n=17); pupa length 4.2–6.3 mm ($\bar{x}$=5.3 mm, s.d.=0.66, n=16); gill length 1.8–3.1 mm ($\bar{x}$=2.6 mm, s.d.=0.33, n=20).

Cocoon shoe-shaped, mid brown; rim of aperture mid brown, reinforced and with fenestrations (Fig. 8). Cocoon surface of thin, amorphous, translucent, elastic substance in which thick, interwoven fibres are sometimes visible.

Gill light brown, generally protruding beyond collar of cocoon, with eight short, forwardly-directed filaments arranged in vertical plane. Main trunk of gill giving rise to four primary branches: two outer single filaments and two inner, each bearing three filaments branching near base (Fig. 253). Filaments slender with crenate margins and rounded distally, their surfaces covered with fine spicules.

Head with 2+2 frontal and 1+1 facial trichomes, all poorly developed and unbranched; surface of head with scattered, enlarged platelets in frontal region and rounded, densely distributed tubercles in facial region.

Thorax with up to 7+7 antero-dorsal, poorly developed, unbranched trichomes. Surface of margin of anterior region and posterior region of thorax with no tubercles, but mid section of thorax with numerous, minute rounded tubercles denser dorsally near raphe, where many are pointed.

Abdominal tergite II with 4+4 simple setae; III–IV with 4+4 simple hooks and 1+1 fine setae in front of outermost hooks; tergite IX with no spines; tergites II–IX with 1+1 well developed areas of spine combs on anterior margins and tergites I and II with groups of spine combs on posterior margins. Sternite IV with no hooks or hairs; V–VII with 2+2 simple hooks; I+I patches of spine combs on anterior borders of sternites IV–VIII.

TAXONOMIC DISCUSSION. Our initial objective was to attempt to clarify the morphotaxonomic position of *S. virgatum* so that we could identify reliably our specimens from Belize. Having researched the Neotropical literature we are now more aware of the extremely confused situation. To adequately resolve

the chaos would involve an enormous amount of research involving the examination of many type specimens and collection of reared material from type localities of *S. virgatum s.s.* (including *S. rubicundulum*), *S. paynei* (including *S. acatenangoense* and *S. mathesoni*) and *S. rubrithorax*. A thorough revision of these species is necessary using the integration of modern techniques and morphology over their whole distributional range (Nearctic and Neotropical) before the status of these species and their synonyms can be reliably made. This does not fall within the scope of this paper. Accordingly, we present an historical account mainly based on publications relating to the Latin American fauna in order to illustrate the problems found in the Neotropical region. We then give our opinions on the information available to us for the Neotropical region. The situation presented in the world inventory of Simuliidae by Crosskey & Howard (1996) for *S. virgatum* and the related species *S. paynei* and *S. rubrithorax* has been used as a basis, as it is considered to be an accurate representation of the current taxonomic position.

Historical perspective

Coquillett (1902) described the male and female of *S. virgatum* from two males and two females collected in New Mexico, USA. He referred to the male as black [actually brownish black – see Figs. 160, 161] and the female with a brownish mesonotum. He mentioned a type with catalogue number 6183 deposited in the USNM. It was not clear whether this referred to a holotype or simply type material [i.e. 4 syntypes], as the USNM number refers to all type material for a species. In 1914 Malloch provided a redescription of the male of *S. virgatum* based on the 'type specimen and another specimen from the same type locality also taken by Mr Barber'. He described the female from 'two type specimens from Las Vegas New Mexico, August (H.S.Barber)'. Apparently he regarded Coquillett's original specimens as syntypes. Later, Stone (1948) designated the male 'type' in the type series of Coquillett as lectotype, but did not label it as such. It is now clear (Dr F.C.Thompson, USNM, personal communication) that Coquillett was referring to a holotype because he placed the red type label on the specimen, recorded it in the USNM type register on 10 February, 1902 as the type and indicated that *S. virgatum* was represented by four specimens. Malloch (1914) described the male and female as black-brown, but noted that the scutum of the female was reddish in the paratypes, unlike specimens from Los Angeles, California [colour not given] in the USNM collection. In the same paper Malloch (1914) described a new species, *S. hippovorum*, based on a black female collected in the ear of a horse in southern Mexico. He compared this species to the description of Bellardi for *S. cinereum* and could not decide whether the two species were conspecific. *Simulium virgatum* and *S. hippovorum* were placed in separate species groups. Knab (1915) then described the female of a new species *S. rubicundulum* collected in Córdoba, Mexico. He also referred to a female [labelled in USNM collection as paratype] from Las Vegas Hot Springs in New Mexico and collected by Barber on August 7, which Stone (1948) thought was one of the type series of Coquillett. The reddish shade with grey pruinosity of the scutum and the scutal pattern that changed with light direction was noted. Knab compared the specimen with two females of *S. rubrithorax* sent by Lutz from Brazil, but considered the two species to be distinct. *Simulium rubrithorax* was recorded with a longer terminal joint of the antenna, narrower and parallel sided frons, hairs on frons coarser and in four rows and not scattered. We confirm the parallel sides of the frons but found the other characters to vary intraspecifically in *S. rubrithorax*. The variation in colour and the interpretation of this had already appeared at this stage at a time when species descriptions were based on external morphology. In 1927 Dyar & Shannon reviewed the USNM collection of Simuliidae and made preparations of male and female genitalia. They figured these for *S. virgatum* and compared the types in the USNM of *S. hippovorum* and *S. rubicundulum* with *S. virgatum* considering them as conspecific. Consequently, the two former names were synonymised with *S. virgatum*, although no explanation nor figures of the other two species were given.

Hoffmann (1930b) described females collected biting donkeys and mules as *Simulium virgatum chiapaueuse* from the South Chiapas focus of Mexico. He referred to them as the Chiapas race of *S. virgatum*, which differed from *S. virgatum s.s.* in the width of the stem of the genital fork, the enlarged knob to the genital fork and reduced size of the anterior processes on the lateral arms. In 1931 he described the pupa and larva under the name *S. chiapanense*. Later, Dampf, reported in Bequaert (1934), regarded *S. chiapanense* as synonymous with *S. virgatum*. Following a comparison of the figures of the genital fork and paraprocts in Hoffmann (1930b) and figures of Vargas & Díaz Nájera (1957) for *S. virgatum*, and the gill figured in these papers we agree that the specimens involved appear to be conspecific. No type material of *S. chiapanense* was found for comparison and is presumed lost. Whether the specimens examined by Vargas & Díaz Nájera (1957) are *S. virgatum s.s.* can not be decided at this stage.

Over a decade later *S. virgatum* was again reviewed by Vargas and co-workers in Mexico. In their paper on the Simuliidae of Mexico Vargas *et al.* (1946) maintained that two new names had been provided independently to replace *S. cinereum* Bellardi from Mexico because the name was preoccupied. Firstly,

Coquillett (1902) [as 1903] had produced the name *S. virgatum* and then Speiser (1904) *S. tephrodes*. In fact Coquillett made no mention of Bellardi's species when he described *S. virgatum* from the USA. Similarly, Speiser correctly noted that *S. cinereum* Bellardi from Mexico was preoccupied by *S. cinereum* Macquart for a French species and proposed the replacement name *S. tephrodes*, but made no link between this species and *S. virgatum*. Stone (1948) removed *S. cinereum* Bellardi and *S. tephrodes* from the synonym list of *S. virgatum* because there was no evidence provided to link *S. tephrodes* with *S. virgatum*. However, in the Catalogue of Diptera of America north of Mexico Stone *et al.* (1965) placed *S. cinereum* Bellardi as a synonym of *S. virgatum*. Additionally, Vargas *et al.* (1946) maintained that the name *S. virgatum* at that time referred to two species, one Nearctic and the other Neotropical. They argued that if the species collected by Saussure in Morelia, Mexico and described by Bellardi as *S. cinereum* is the same as that that occurs abundantly in Chiapas State then the name *S. virgatum* should be applied to the Neotropical species and consequently *S. rubicundulum* Knab and *S. chiapanense* Hoffmann would be junior synonyms. In this case *S. hippovorum* Malloch [described from southern Mexico] would apply to the Nearctic species described as *S. virgatum* by Coquillett from the USA. If the material collected at Morrelia is the same as the Nearctic species then *S. virgatum* represents the USA material and *S. hippovorum* is its junior synonym and *S. rubicundulum* remains valid for the Neotropical specimens from Mexico. No mention was made of *S. tephrodes*. They were unable to decide whether the material from Morrelia was Neotropical or Nearctic because this locality lies on the border between the two zones. As they had not seen the material from Morrelia with reservation they decided that the name *S. virgatum* should apply to specimens from the Nearctic and Neotropical specimens would be recorded as *S. rubicundulum*. We found difficulty in inderstanding this argument, but their final conclusion has maintained a more stable taxonomy for the species.

Stone devoted his 1948 paper to clear some of the confusion surrounding the identity of *S. virgatum* and describe a new species *S. solarii*, with which it had been previously confused. He discussed in detail his reasons for maintaining *S. hippo*vorum and *S. rubicundulum* as synonyms of *S. virgatum* based on his finding of intraspecific variation in the absence or presence of hairs on the anepisternum from reared material collected in Texas and Malloch's incorrect record of a lack of teeth on the claws of *S. hippovorum*. He also maintained the synonymy of *S. chiapanense* with *S. virgatum*, after comparing Hoffmann's figures (1930b) with type material of *S. virgatum*. He pointed out errors in Dyar & Shannon's figures (1927) of *S. virgatum* and maintained that the short description and figures by Stains and Knowlton (1943) of *S. virgatum* from the USA referred to two species: the female was *S. virgatum*, but the male was *S. solarii* described by Stone in this paper. Stone further maintained that Vargas *et al.* (1946) assumed Stain & Knowlton's male of *S. virgatum* to be correct, based their interpretation of *S. virgatum* on this, and consequently resurrected the name *S. rubicundulum* for true *S. virgatum*. Stone also synonymised *S. mathesoni*, described in the male by Vargas (1943) with *S. virgatum* based on the morphology of the ventral plate, after having examined males, females and pupae and larvae of specimens collected from Córdoba, Mexico and identified by Vargas as *S. mathesoni*. In 1955 Dalmat in his monograph on the Simuliidae of Guatemala followed Vargas *et al.* (1946) in accepting *S. rubicundulum* as a species in Central America and not *S. virgatum*. Additionally, he regarded *S. mathesoni* as a valid species and not a synonym of *S. virgatum* proposed by Stone (1948). He also maintained that *S. acatenangoense* Dalmat had been synonymised with *S. virgatum* by Stone (1948), but we found no mention of this in the latter paper. In a later paper Vargas & Díaz Nájera (1957) agreed with Stone (1948) on the synonymy of *S. rubicundulum* with *S. virgatum*, but placed *S. mathesoni* as a junior synonym of *S. paynei* and not *S. virgatum*. The latter has been accepted in the world inventory of Simuliidae of Crosskey & Howard (1996) and Ibáñez Bernal (1992) in his revision of the subgenus *Hemicnetha*. He also regarded *S. bricenoi* Vargas, Martínez Palacios & Díaz Nájera and *S. paynei* Vargas as closely related to *S. virgatum*. Lists of the numerous references to the morphology of this species and its relatives can be found in Vargas (1942a, 1945) and Ibáñez Bernal (1992).

More recent work by Muhammad (1988) showed through cytological analysis of larvae collected mainly from the southwestern USA and Guatemala that *S. virgatum* is a sibling species complex of four cytotypes, denominated A-D. In this thesis his main emphasis was on descriptions of polytene chromosomes and the relationships between the different cytotaxa studied, rather than correlating cytological and morphological variation in the complex. Later, Peterson & Kondratieff (1994), in their review of the black flies of Colorado State in the USA, recommended a review of the taxonomy of this species complex because collections made in the same and other localities collected by Muhammad in Texas suggested to these authors that Muhammad may have misidentified some of his specimens and was dealing with morphologically different species and not just *S. virgatum s.s.*

Our findings

Our limited investigations into the taxonomy of *S. virgatum* revealed the following. Henrique de Saussure

was a Swiss collector based at the Museum of Natural History in Geneva, Switzerland. Amongst other insects that he had collected in Mexico he sent Simuliidae to Bellardi, which resulted in the description of *S. cinereum*. We have attempted to locate the type material. None of the specimens was deposited in the Natural History Museum, Geneva, which has no Neotropical Simuliidae species represented (Dr Bernhard Merz, personal communication). We were unable to discover whether this species was deposited by Bellardi in Turin University. Therefore, for taxonomic stability we accept *S. cinereum* Bellardi as a synonym of *S. virgatum* Coquillett.

We examined some of the type specimens of *S. virgatum* and *S. rubicundulum* and compared them with our specimens from Belize. The holotype of *S. virgatum* consists of a pinned male with a red 'Type' label from Las Vegas Hot Springs, New Mexico, USA. The abdomen had been removed and mounted on a slide. Both parts are now labelled holotype [see Material Examined for label details]. The holotype of *S. rubicundulum* consists of a pinned female with a red 'Type' label from Córdoba, Mexico without abdomen and only a fore and hind leg. The abdomen and a hind leg are mounted on a slide. Both parts are now labelled as holotype [see Material Examined for label details]. The single paratype of *S. rubicundulum* is a pinned female with lightly damaged legs from Las Vegas Hot Springs, New Mexico, USA with a paratype label [see Material Examined for label details]. This specimen is believed to be one of the female paratypes of Coquillett's original four specimens used in his description (1902) of *S. virgatum*. The holotype male of *S. virgatum* corresponds in colour and scutal pattern to the black form of male from Belize (Figs. 158, 159, 160, 161). Apart from coloration the brown form male from Belize showed a slightly different scutal pattern to the holotype (Figs. 156, 157). However, both forms are morphologically similar to the holotype, except for differences in the genitalia. The holotype possesses a large and small sub-terminal spine on one gonostyle, but only has one large spine on the other gonostyle (Figs. 193, 194). In the Belize brown form only one spine is present and the gonostyle has more sinuous dorsal and ventral margins than in *S. virgatum* holotype (Fig. 191). Also the paramere has fusiform spines from the median part to the basal plates (Fig. 234) unlike the holotype with only median spines (Fig. 236), and the ventral plate keel of the holotype is more elongated as are its basal arms (Fig. 215) than the Belize brown form (Fig. 213). The black form male from Belize shows a similar scutal pattern to the holotype (Figs. 158, 159, 160, 161), but has genitalia similar to the brown males from Belize (Figs. 214, 235), except there are two gonocoxite spines (Fig. 192) as in one of the holotype gonostyles. The female from Belize corresponds in coloration (Figs. 45, 46) and morphology with the female holotype and paratype of *S. rubicundulum* (Figs. 47, 48).

We also compared *S. virgatum s.l.* adults from Belize with specimens under this name from Guatemala, Mexico and Panama in the BMNH collection, as well as with material from Ecuador and Venezuela identified previously as *S. paynei* by A.J. Shelley following examination of the lectotype, *S. acatenangoense* [synonym of *S. paynei*] from Guatemala identified by Dalmat who described the species, *S. mathesoni* [synonym of *S. paynei*] from Mexico identified by Vargas who described the species, and *S. rubrithorax* from Brazil [identified by A.J. Shelley]. Details of the labels of these specimens are found in Material Examined. Females of *S. virgatum s.l.* from Belize are morphologically similar to the other material under this name and to *S paynei and S. rubrithorax*, with variation in scutal coloration from orange to dark brown and colour differences in the scutellum, postnotum and pleura (Table 2, Figs. 45, 46, 49, 50, 51, 52, 53, 54, 55, 56). In males coloration is more variable ranging from orange to black (Table 3, Figs. 156, 157, 158, 159, 162, 163, 164, 165, 166, 167, 168, 169). Also *S.paynei* (as *S. mathesoni*) from Mexico has the hind leg femur all black except for the basal articulation. Male genitalia were also variable. Specimens of *S. paynei* from Ecuador and Venezuela are similar to the Belize specimens generally with single spines on the gonostyles, but in some cases *S. paynei* males from Ecuador and a male (as *S. mathesoni*) from Mexico have two spines on the gonostyle (Figs. 191, 192, 195, 196, 197, 198). Also, spines on the paramere do not extend to the basal plate in *S.paynei* and *S.rubrithorax* (Figs. 234, 235, 237, 238, 239). The morphology of the ventral plate is similar in *S. virgatum s.l.* from Belize, *S.paynei* and *S.rubrithorax*, but has a more developed keel in the holotype male in the USA (Figs. 213–218).

Ibáñez Bernal (1992) used differences in branching patterns of pupal gill filaments for distinguishing *S. paynei* from *S. virgatum s.l.* We also observed variations in the configuration of gill filaments of pupae identified as *S. virgatum s.l.* (Belize), *S. paynei* (Ecuador) and *S. rubrithorax* (Brazil). Additionally, in the two latter species the posterior part of the thorax has tubercles and the inner three setae of abdominal tergite II are more strongly developed as spines in *S. rubrithorax* from Brazil. However, because of the current confusion surrounding the identities of these species we are reticent to interpret their significance in terms of species diagnostic characters.

In conclusion we have regarded our specimens from Belize as *S. virgatum s.l.* with which *S. paynei* (including *S. acatenangoense* and *S. mathesoni*) and *S. rubrithorax* in the BMNH collection appear to be conspecific. It would appear that *S. virgatum s.s.* from the USA may be one species that is distinguished from what we have referred to as *S. virgatum s.l.* in the form

of the male genitalia. We presume that the holotype of *S. rubicundulum* is *S. virgatum s.s.* because both were reared from the same locality in the USA at the same time by Barber. However, the paratype from Mexico may fall within our *S. virgatum s.l.*, but without cytological or molecular data this cannot be resolved because no obvious morphological differences occur in females. The way forward is to use integrated taxonomic techniques to discover the meaning of morphological variations in terms of cytospecies of the *S. virgatum* complex.

DISTRIBUTION. *Simulium virgatum* s.l. was uncommon in Belize being found mainly in Mountain Pine Ridge up to 700 m (Table 1, Material Examined, Maps 2, 9), sympatrically with other species of *Hemicnetha* recorded in this paper and *S. callidum*, *S. gonzalezi*, *S. metallicum s.l.* and *S. samboni*. Its distribution (including *S. paynei* and *S. rubrithorax*) is as follows: Argentina, Brazil, Canada, Colombia, Costa Rica, Ecuador, Guatemala, Guyana, Nicaragua, Mexico, Panama, Peru, USA, Venezuela (Crosskey & Howard, 1996).

BIOLOGY AND MEDICAL IMPORTANCE. *Simulium virgatum s.l.* was collected in Belize on vegetation in 5m to 35m wide, fast flowing rivers, in parts of the river where the current is faster or in waterfalls. In Belize *S. virgatum s.l.* was apparently zoophilic and in Guatemala, Mexico and North America bites horses and cattle but not man. In the Neotropical region it breeds in clear, medium to large rivers usually in faster flowing sections at high altitudes (Dalmat, 1955; Ibáñez Bernal, 1992; Peterson & Kondratieff, 1994). In Ecuador *S. paynei* has been collected biting man in localities in the Andes (Material Examined).

Simulium (*Notolepria*) *gonzalezi* Vargas & Díaz Nájera

(Figs. 6, 19, 57, 58, 91, 103, 116, 128, 141, 170, 171, 199, 219, 220, 240, 254).

A species from Latin America with a restricted distribution, which is closely related to members of the *S. exiguum* complex. It is one of the few species in the Neotropical region in which dichoptic males commonly occur.

Simulium gonzalezi Vargas & Díaz Nájera, 1953: 235. LECTOTYPE ♀, GUATEMALA: Livingston, 20.iii.1906 (*Schwarz & Barber*) (USNM.) [Lectotype designation by Shelley *et al.*, 1997: 14.]
Simulium gonzalesi. [Incorrect subsequent spelling by Vulcano, 1967: 16.12.]

FEMALE. General body colour black. Body length (specimens on slides) 1.6–2.2mm ($\bar{x}$=1.8 mm, s.d.=0.23, n=7), wing length 1.5–1.8 mm ($\bar{x}$=1.6 mm, s.d.=0.12, n=7), wing width 0.6–0.9 mm ($\bar{x}$=0.8 mm, s.d.=0.08, n=7). Body length (pinned specimens) 1.4–2.2 mm ($\bar{x}$=1.7 mm, s.d.=0.24, n=13), wing length 1.1–1.7 mm ($\bar{x}$=1.6 mm, s.d.=0.17, n=12), wing width 0.5–0.9 mm ($\bar{x}$=0.8 mm, s.d.=0.11, n=12).

Head – dichoptic with dark red eyes showing green highlights, nudiocular area absent (Fig. 19). Rest of head black with silver pruinosity, mouthparts and antennae brown. Cibarium unarmed (Fig. 31).

Thorax – greyish black with one median and a pair of posteriorly divergent, sub-median, darker black lines running whole length of scutum irrespective of light direction; scutum covered with numerous, short, adpressed, dark setae and discrete groups of brass-coloured setae with greenish reflections that are absent along mid-line (Figs. 57, 58). Scutellum with similarly coloured setation and postnotum black with dull greyish pruinosity. Subcostal vein and basal section of Radius of wing bare. Legs yellow to very light brown, except fore tarsi, mid and hind coxae, distal three quarters of hind femora and distal half to two thirds of hind tibiae black (Fig. 91). All femora and tibiae with scales; claws curved, without basal teeth, except sometimes present in a reduced form on hind leg.

Abdomen – tergites shiny, brownish black with silver pruinosity on second segment (Fig. 103), sternites brownish black, genitalia light brown. Eighth sternite highly sclerotised with 1+1 groups of 8–12 stout setae. Gonopophyses small, slightly pointed and with few setae on anterior margins sclerotised on inner margin, glabrous (Fig. 116). Paraprocts broadly rectangular, almost as wide as long with short, triangular, anteriorly-directed process (Fig. 128). Genital fork slender and sclerotised stem, long and thin lateral arms with sclerotised anteriorly directed processes usually well developed but sometimes poorly developed as described previously by Shelley *et al.* (2001) (Fig. 141). Spermatheca oval, highly sclerotised with no external sculpturing and width of membranous area of insertion of spermathecal duct about half maximum width of spermatheca.

MALE. General body colour black. Two forms of male occur, a normal holoptic form and a dichoptic form in the proportion 6:22 (n=28) respectively.

Holoptic Form: body length (specimens on slides) 1.7–2.1 mm (n=2), wing length 1.4 mm (n=2), wing width 0.8 mm (n=2); body length (pinned specimens) 1.5–1.8 mm ($\bar{x}$=1.7 mm, s.d.=0.13, n=4), wing length 1.1–1.5 mm ($\bar{x}$=1.4 mm, s.d.=0.20, n=4), wing width 0.5–0.9 mm ($\bar{x}$=0.7 mm, s.d.=0.15, n=4).

Head – dark red eyes, smaller facets with green reflections. Other head coloration as in female.

Thorax – velvet black, with anterior and posterior margins and anterior two thirds of lateral margin of scutum silver pruinose (seen when specimen tilted); scutum with numerous, short, adpressed, brown setae

and groups of brilliant gold setae with greenish reflections (Figs. 170, 171). Wing venation, and leg coloration as in female (Fig. 91).

Abdomen – tergites velvet black with silver ornamentation as follows: tergites II, VI and VII completely silver except for median area in both segments; tergite IX shiny, greyish black. Genitalia brownish black. Gonocoxite sub-rectangular; gonostyle small, subtriangular, one third as long as gonocoxite and with very small distal spine (only visible with 100X objective)(Fig. 199). Ventral plate triangular with well developed basal arms, lightly sclerotised, with hairs on keel short, diffuse and mainly around median part (Fig. 219). Median sclerite pyriform with apical incision (Fig. 219). Paramere with several apical spines (Fig. 240).

Dichoptic form. Body length (specimens on slides) 1.5–2.0 mm ($\bar{x}$=1.7 mm, s.d.=0.20, n=12), body length (pinned specimens) 1.1–1.4 mm ($\bar{x}$=1.3 mm, s.d.=0.15, n=3), wing length 1.1–1.3 mm ($\bar{x}$=1.2 mm; s.d.=0.06, n=12), wing width 0.4–0.7 mm ($\bar{x}$=0.7mm; s.d.=0.10; n=12).

Head – coloration and form as in female except, frons narrower and antennae and antennal flagellomeres longer than those of female.

Thorax – coloration and setation as in female (Figs. 57, 58), except claws of male type.

Abdomen – coloration as in holoptic male, except silver ornamentation on tergite VI may cover whole segment and on tergite VII may be reduced to lateral area. Male genitalia as in holoptic form, except ventral plate more quadrangular and with less well developed keel (Fig. 220).

PUPA. Female and dichoptic male pupae (specimens preserved in glycerine in polypropylene phials associated with pinned adult). Cocoon length dorsally 1.4–2.1 mm ($\bar{x}$=1.8, s.d.=0.17, n=18), ventrally 1.8–2.5 mm ($\bar{x}$=2.1 mm, s.d.=0.22, n=15), pupa length 1.9–2.5 mm ($\bar{x}$=2.5 mm, s.d.=0.33, n=13), gill length 1.1–2.0 mm ($\bar{x}$=1.4 mm, s.d.=0.28, n=16). Holoptic male pupae: cocoon length dorsally 1.9–2.2 mm ($\bar{x}$=2.1 mm, s.d.=0.13, n=4), ventrally 1.9–2.3 mm ($\bar{x}$=2.2mm, s.d.=0.16, n=4), pupa length 2.2–2.4 mm ($\bar{x}$=2.3 mm, s.d.=0.07, n=4), gill length 1.3–1.8 mm ($\bar{x}$=1.6mm s.d.=0.27, n=4).

Cocoon slipper-shaped as in Fig. 6, mid to dark brown, composed of fine fibres, with reinforced rim to anterior aperture without central protuberance.

Gill light brown, with six forwardly-directed slender filaments. Main trunk giving rise to three primary branches each of which bears a single bifurcation near base, one dorsal primary branch and two adjacent ventral primary branches; most basal bifurcation on primary branches usually on dorsal; inner and outer ventral primary branches may bifurcate at same level or either one may bifurcate more basally (Fig. 254). All filaments approximately of same length with upper filament of inner ventral primary branch usually longest. Filament bifurcations all occur in vertical plane.

Head of dichoptic male more similar to female than holoptic male, being broader dorsally in former two. Distribution of tubercles and trichomes same in females and males: 2+2 frontal trichomes, more ventral simple to trifid with more dorsal small and simple, 1+1 facial trichomes 3–5 branched, round tubercles only present in group at ventral base of frontoclypeus.

Thorax with 5+5 well developed antero-dorsal rounded trichomes with 2–7 branches; distribution of tubercles variable from devoid except for small area at base of gill in middle of thoracic sclerite, to patches of large tubercles surrounding gill base and sometimes midway along dorsal (where some are pointed) and ventral margins and smaller tubercles on posterior half, but never with large tubercles covering anterior half as *S. gonzalezi* in Ecuador (See Shelley *et al.* 1989).

Abdominal tergite II with 4+4 simple hairs in single line on posterior border and 1+1 simple hairs in mid segment lateral to the outer hair in the line; III–IV with 4+4 hooks, IX with 1+1 strong simple spines and 1+1 antero-lateral areas of spine combs. Sternite IV with 1+1 areas of spine combs on postero-lateral border; sternite V with 2+2 bifid or trifid hooks; sternite VI with 2+2 bifid hooks and sternite VII with 2+2 hooks, of which inner pairs bifid and outer simple, with 1+1 patches of fine spine combs anterior and between these hooks on posterior margin of segments and posterior margins of sternites VIII and IX.

TAXONOMIC DISCUSSION. *Simulium gonzalezi* was the name given by Vargas & Díaz Nájera (1953) to specimens previously identified as the closely related species *S. exiguum* from Guatemala and Mexico. Their criteria for distinguishing these two species were the form of the gonophyses, genital fork and paraproct in females, the gonostyle and ventral plate in males and the gill in pupae. Later studies on variation in leg colour, form of gonopophyses and gill filament number highlight the need to determine the validity of these characters for species determinations in certain regions. Shelley *et al.* (1989, 1997, 2000, 2001) discussed these in detail and provided a table (Shelley *et al.*, 2001) noting morphological differences between the four most closely related species *S. cuasiexiguum, S. exiguum, S. gonzalezi* and *S. paraguayense*) [In this paper the authors incorrectly refer to the basal two thirds of the hind leg tibia as being light, instead of only the basal third.] Additionally, in *S. cuasiexiguum* gill filament branching is more splayed and distal and trichomes are usually shorter, simple or bifid. Variation encountered in *S. gonzalezi* in Belize further reduces the number of species specific characters present in

this species: the fore leg coxae and hind leg trochanters may be dark or light in colour (also seen in Ecuador specimens); distal three quarters of hind femora and distal half to two thirds of hind tibiae black; sclerotised anteriorly directed processes of genital fork usually well developed, but sometimes poorly developed as described in Vargas & Díaz Nájera (1953) and figured in Shelley *et al.* (2001); inner and outer ventral primary branches of gill of Belizean specimens (Fig. 254) bifurcate far more basally than those in specimens from the onchocerciasis foci of Guatemala and Ecuador (Figs. 255, 256) and tubercles more widely distributed in both the thorax and frontoclypeus in Ecuador specimens (Figs. 13, 17 as for *S. exiguum s.l.* in Shelley *et al.*, 1989). In a single specimen from the onchocerciasis focus in western Guatemala gills are longer and tubercles more widely distributed on the thorax and frontoclypeus as in specimens from Ecuador. When identifying *S. gouzalezi* in Central America the above variations seen in Belizean specimens should be considered as well as the presence in *S. exiguum s.l.* of the dichoptic male condition and variation in gill filament number (details in Ibáñez Bernal, 1992; Shelley *et al.*, 1989). The slight differences in morphology between this population and those in Central America as well as the differences in biting behaviour could indicate the presence of a species complex in *S. gouzalezi*.

DISTRIBUTION. This species was uncommon in Belize, being found in low numbers in all districts of the country at both low and high altitudes (Table 1, Material Examined, Maps 2, 10). *Simulium gouzalezi* has a limited distribution in the Neotropical region, largely occurring in some countries of Central America (Guatemala, Mexico and Belize) as well as Ecuador in South America (Crosskey & Howard, 1996; Shelley *et al.* 1989, 2001).

BIOLOGY AND MEDICAL IMPORTANCE. Larvae and pupae were found in small numbers attached to dead leaves and submerged vegetation in parts of the river where the current is faster in a broad spectrum of river types ranging from slow flowing 2m wide shallow creeks to fast flowing 50 m wide rivers (Table 1, Material Examined). In larger rivers *S. gonzalezi* was often associated with species of water plant of the family Podostemaceae and at one locality on the R. Macal large numbers of immature stages were found. Only one specimen was collected biting man in Belize. In Guatemala and Mexico it will bite man and animals (horses, mules, dogs, cats, chickens – Dalmat (1955), as *S. exiguum*), and is a secondary vector of human onchocerciasis. In Ecuador this species is limited to Esmeraldas Province in the north, breeds only in larger rivers and is zoophilic (Shelley, 1988a; Shelley *et al.* 1989).

Simulium (*Psaroniocompsa*) *ganalesense* Vargas, Martínez Palacios & Díaz Nájera

(Figs. 20, 32, 59, 60, 92, 104, 117, 129, 142, 172, 173, 200, 221, 241, 257).

This is an uncommon species previously recorded from only three states in Mexico and now Belize. We are treating the specimens from Belize as this species until the variation in pupal gill branching can be evaluated.

Simulium (*Psaroniocompsa*) *ganalesense* Vargas *et al.*, 1946: 114. HOLOTYPE ♂. MEXICO: San Luis Potosi, Municipio de Guerrero, Hacienda de Ganales, 11.iv.1944 (*Matías Macías*) (INDRE [formerly ISET], no. 3782). [Examined.]

FEMALE. General body colour black. Body length (specimens preserved in alcohol) – 1.8–2.4 mm (x̄=2.2 mm, s.d.=0.18, n=10), body length (pinned specimen) 1.9 mm, wing length 1.5–1.7 mm (x̄=1.6 mm, s.d.=0.05, n=10), wing width 0.5–1 mm (x̄=0.9mm, s.d.=0.13, n=10). Paratypes in alcohol – body length 2.8 mm (n=1), wing length 1.6 mm (n=1), wing width 0.8 mm (n=2).

Head – dichoptic with dark red eyes, nudiocular area absent (Fig. 20). Rest of head black with silver pruinosity, mouthparts black and antennae black with scape pedicel and base of first flagellomere brown. Cibarium with well developed and highly sclerotised cornuae, highly sclerotised margin to central trough with 2 or 3 irregular rows of strong teeth, absent in median area (Fig. 32).

Thorax – black with silver pruinose pattern that varies in form with light illumination. With light source anterior to specimen 1+1 silvery white, sub-median vittae extending from anterior to posterior silver margin and extending laterally near anterior margin to join lateral, silver margin; 1+1 black, comma-shaped bands occupying anterior margin to humeri and tails extending for almost half scutal length (Fig. 59). Scutum covered with numerous, short, adpressed, brass-coloured setae. With light source posterior silver vittae narrower, not expanding anteriorly and cunae reduced to small indistinct triangles on anterior margin (Fig. 60). Scutellum black with silvery grey pruinosity with similar setation to scutum and some black bristles, postnotum black with silver pruinosity and glabrous. Wings with Subcostal vein and basal section of Radius bare. Fore legs brown, except external face of tibiae white, tarsi dark brown; mid legs dark brown, except basal articulation of tibiae and tarsi dirty cream; hind legs dark brown except for basal third of tibiae, basal two thirds of basitarsi and basal half of second tarsal segments dirty cream (Fig. 92). All femora and tibiae with scales. Proportion of legs as in Fig. 92. Claws curved, without basal teeth.

Abdomen – tergites shiny black with silver pruinosity on second segment, sternites greyish black, genitalia brownish black (Fig. 104). Eighth sternite sclerotised with 1+1 groups of 8–10 mainly small setae, but with 3 or 4 stout setae laterally; gonopophyses small, covered with small setae and sclerotised on inner margin (Fig. 117). Paraproct broadly oval, almost all sclerotised (Fig. 129). Genital fork slender with long sclerotised stem usually with no terminal knob, long lateral arms sclerotised at base and expanded apically; well developed and sclerotised anteriorly-directed processes (Fig. 142). Spermatheca oval, highly sclerotised with no external sculpturing and groups of internal setae; width of membranous area of insertion of spermathecal duct between a quarter to half maximum width of spermatheca.

MALE. General body colour black. Body length (pinned)– 1.7 mm (n=1), wing length 1.5 mm (n=1), wing width 0.9 mm (n=1). Paratype specimens from INDRE and USNM: Body length (specimens preserved in alcohol) 2.6–3.4 (n=2), wing length 0.7–1.5mm ($\bar{x}$=1.3 mm, s.d.=0.45, n=3), wing width 0.7–1.6 mm ($\bar{x}$=1.1 mm, s.d.=0.45, n=3).

Head – dark red eyes, other head coloration as in female.

Thorax – velvet black, with lateral and posterior margins of scutum silvery grey pruinose. With light source anterior 1+1 sub-median to lateral silver pruinose cunae on anterior margin of scutum extending as short tails posteriorly for three quarters length of abdomen, but not joining posterior margin (Fig. 172). With light source posterior scutum velvet black with only tails of silver cunae visible (Fig. 173). Scutal vestiture as in female, scutellum and postnotum as in female. Wing venation and leg coloration as in female (Fig. 92).

Abdomen – tergites velvet black with silver ornamentation as follows: tergites II, VI, VII and VIII laterally silver. Gonocoxite sub-rectangular; gonostyle small, triangular, shorter than gonocoxite and with small, blunt, distal spine (Fig. 200). Ventral plate crescent-shaped with poorly developed, sclerotised basal arms, keel well developed; coarse hairs covering most of ventral plate, but longer on keel (Fig. 221). Median sclerite sub-rectangular, expanded laterally (Fig. 221). Paramere with several large spines interspersed with smaller spines (Fig. 241).

PUPA. Cocoon length dorsally 2.3–2.8 mm (n=2); ventrally 2.8–3.1 mm (n=2); pupa length 2.8–3.0 mm (n=2); gill length 2.4–3.9 mm (n=2). Paratypes from INDRE and USNM: Cocoon length dorsally 2.2–3.7 mm ($\bar{x}$=2.7 mm, sd= 0.5, n=6), ventrally 2.9–3.9 mm ($\bar{x}$=3.3 mm, sd= 0.4, n=8), pupa length 1.9–2.8 mm ($\bar{x}$=2.3 mm, sd= 0.35, n=6), gill length 1.6–2.1 mm ($\bar{x}$=1.8 mm, sd= 0.18, n=8).

Cocoon light brown, slipper-shaped, composed of lightly woven threads and with reinforced anterior margin with median protuberance.

Gill light brown with six forwardly-directed, thin, tubular filaments that arise from thorax in a bunch. Main trunk of gill divides into two basally; dorsal primary branch then divides into two basally and each of these secondary branches again bifurcates almost at same level in about basal third of gill, ventral primary branch bifurcates more basally in about basal tenth of gill (Fig. 257). Filaments all approximately same length, fine, tapering slightly distally with spicules on surface, edges crenate and ends rounded; primary and secondary branches slightly wider basally.

Head with 2+2 well developed, simple or bifid frontal and 1+1 well developed, bifid facial trichomes; surface of head covered with rounded tubercles, larger on frontal region and smaller on sclerites covering eyes.

Thorax with 5+5 well developed simple or bifid trichomes; part of surface of thorax covered with rounded tubercles, larger in anterior third and smaller in posterior third with some spine-shaped tubercles along raphe. Abdominal tergite I with 1+1 simple setae laterally in three locations – anterior margin, anterior part of lateral margin and posterior part of lateral margin; tergite II with row of 4+4 stout spines in middle portion of segment, small bifid seta slightly anterior to most lateral spines in row, 1+1 simple setae on mid part of lateral border of segment, 1+1 simple, sub-median setae on anterior margin of segment; setation of tergites III–IV as tergite II except row of 4+4 hooks more strongly developed; tergites V–VII with 3+3 small setae in row in middle portion of segment, 1+1 simple setae on lateral borders (only in V) in this portion and 1+1 groups of poorly developed spine combs on anterior margins of V and VI, but better developed in VII; tergite VIII with single row of backwardly-directed stout spines on anterior margin and 1+1 sub-median fine setae in middle portion of segment; tergite IX with 1+1 strong, unbranched terminal spines and row of backwardly-directed, stout spines on anterior margin.

Abdominal sternite III with 2+2 sub-lateral fine setae on anterior margin, sternite IV with 1+1 sub-median bifid hooks, and with 2+2 simple sub-median setae on anterior margin amongst group of weakly developed spine combs; sternite V with 2+2 sub-median (inner simple, outer bifid) strong hooks, 1+1 groups of spine combs anterior to them, and 2+2 simple setae lateral to them; sternites VI–VII with 2+2 well developed sub-median (bifid) and sub-lateral (simple) hooks, 1+1 groups of spine combs anterior to them, 2+2 fine setae amongst spine combs; sternite VIII with 1+1 patches of sub-median spine combs on anterior border.

TAXONOMIC DISCUSSION. The adults, pupa and larva of *S. ganalesense* were described from a single locality

in Mexico by Vargas *et al.* (1946) and placed in the subgenus *Byssodon*. Subsequently, Coscarón and Ibañéz Bernal (1995) provided a more detailed description of these stages based on an examination of type material and assigned the species to the subgenus *Cerqueirellum* (defined in Py-Daniel, 1983). Most of the species in this subgenus are regarded by Shelley (1988b) as belonging to the *amazonicum* group of the subgenus *Psaroniocompsa*, an opinion also held by Crosskey and Howard (1996). We now also include *S. ganalesense* in *Psaroniocompsa*. The morphology of adults corresponds to that seen in the *amazonicum* species group as defined in Shelley (1988b) and discussed in Shelley *et al.* (1997). Generally, genitalia of both sexes for these species are relatively similar, the interspecific differences lying in the adult scutal patterns and gill morphology. In the female scutal pattern *S. ganalesense* and the species from Belize resemble the following species of the group: *S. amazonicum, S. chaquense, S. oyapockense s.l., S. roraimense* and *S. sanguineum*. Male scutal pattern varies intraspecifically, but that of the species in Belize is closer to *S. roraimense, S. sanguineum* and *S. chaquense*. The pupa of *S. ganalesense* and our specimens from Belize have six gill filaments and in this respect are similar to *S. oyapockense s.l.* and *S roraimense*, but the configuration of the gill separates the species from one another. The filaments of *S. ganalesense* may arise from the cephalothorax in a bunch, whereas in *S. oyapockense s.l.* and *S. roraimense* they are arranged in a vertical line and in our specimens from Belize gill branching is more distal.

Vargas *et al.* (1946) refer to a holotype male (no. 3782) and an allotype female (no. 3843) mounted part on slides and part on pins, 18 females and males conserved in alcohol and pupae conserved in alcohol. All this type material was collected at the same locality on the same day and deposited in INDRE. Since then some of the material has been dissected, re-labelled, in the case of spirit material put in new vials, and some sent to the USNM and possibly other institutions. We have examined type material from INDRE as follows: slide preparation of male holotype consisting of a pair of gonocoxites and gonostyles, a paramere and ventral plate; a male paratype slide preparation with the genitalia as indicated in the holotype plus the median plate and two pupal gill; [the parts of these type specimens not present on these two slides were not examined by us and may be lost or were not sent by INDRE]; complete pinned male paratype (not previously indicated as type material but now labelled as such) in reasonable condition, despite having been recovered from alcohol; a female paratype (labelled as allotype) dissected on a slide with the legs, wings, posterior portion of abdomen and antenna; a paratype female dissected on a slide with the wings, legs, antennae, cibarium, posterior portion of abdomen; a paratype female dissected with head and abdomen complete except posterior end removed and dissected and wings and legs missing [this was not labelled as paratype but is certainly a paratype based on the details of the label and has been labelled accordingly]; a pinned female paratype (recovered from alcohol) with the posterior part of the abdomen missing is in good condition and shows a clear scutal pattern – none of the slides with female abdomens could be associated with this specimen. In alcohol there are five complete females and remnants of a male, all of which have dried out and later been preserved in alcohol. We presume that these are *S. ganalesense* paratypes from the collecting details, but without dissection species identification is impossible because of the poor state of the material. Eight pupae and two pupal exuviae are conserved in alcohol [as well as a tube of larvae] and have been labelled as paratypes and a paratype pupal exuviae (of a female) on a slide were also examined. We have also examined material (2 pupae, 3 males, 2 females) conserved in alcohol from the USNM collection from the type locality of *S. ganalesense*. The label is of ISET (now INDRE) in Mexico with the collector's name, date and locality all corresponding to the type locality, together with the identification *S. (B.) ganalesense*. The specimens are paratypes and have been labelled as such. The condition of the material is poor, having been conserved in alcohol for nearly 60 years, but preparations were made of a female, male and pharate male pupa. It is possible that other paratypes are in INDRE since Coscarón and Ibañéz Bernal (1995) examined a female with pupal exuviae, which we did not see.

The scutal pattern of the female based on type specimens (Figs. 61, 62) corresponds with our material from Belize as well as in the rest of the morphology. However, the paraproct figured by Coscarón and Ibañéz Bernal (1995) differs slightly in shape to our material and to that seen in the paratype preparations – in the latter this is because they are *in situ* on the abdomen, but these authors may have figured a specimen that we did not see. The pinned male paratype differs from the male reared from Belize in that the sub-median silver bands run from the anterior to posterior border (Figs. 174, 175), whereas in the Belize male they only extend for about two thirds of the length of the scutum (Figs. 172, 173). This character has been used for distinguishing male *S.oyapockense s.l.* from *S. roraimense* (Shelley *et al.*, 1997) where it does not vary. However, in the series of the closely related *S. sanguineum* in the BMNH both forms may be seen in the same population. More material needs to be obtained from Belize and Mexico to determine whether this variation is interspecific or intraspecific. The morphology of the male genitalia based on type material (Figs. 201, 222, 242) corresponds to our material from Belize (Figs. 200, 221, 241). However, the median sclerite in the Belize specimen has an apical incision not present in

the type material. This is probably due to tearing of the material during preparation. The USNM paratypes revealed minor differences in paraproct and genital fork compared to the Belize material, which may be due to orientation of the dissected parts. The most signicant difference between the Belize and type specimens is in the pupa. The pupal gill filaments may arise from the cephalothorax as a bunch as in the two reared Belize specimens, but in some of the paratype pupae they arise in the horizontal or vertical planes. Coscarón and Ibañéz Bernal (1995) and Vargas *et al.* (1946) recorded a cocoon length of 1.6 mm and a gill length of 1.2 mm. The size of pupae in Belize is far greater in the two specimens measured (cocoon length 2.3–2.8 mm, gill length 2.4–3.9 mm) than the paratypes of *S. ganalesense*: the ratio of distance from base to most distal bifurcation to total gill length is 0.35 (n=2) in the Belize material and 0.19 mm (n=8) in the paratypes. Branching of gill filaments in paratypes resembles that of *S. oyapockense s.l.* and *S. roraimense* (Shelley *et al.*, 1997) from South America in that it is basal and the dorsal bifurcation is most basal, the median bifurcation is usually more distal than the dorsal and the ventral the most distal – in some specimens the median and ventral are at the same level or the median bifurcation is the most distal (Fig. 258). In the two specimens (male and female) from Belize the branching pattern is the reverse. The ventral bifurcation is basal, while the median and dorsal are farther along the gill with the median bifurcation more distal than the dorsal and secondary branching is far more distal. Abdominal chaetotaxy of the paratypes is very similar to the Belize material. At this stage we regard our material as the Belize form of *S. ganalesense* until cytological and molecular studies can elucidate the variation recorded.

DISTRIBUTION. *Simulium ganalasense* was only found to the east of the Maya Mountains at low-lying localities in southern Belize (Table 1, Material Examined, Maps 2, 11). Previously it had only been recorded from the states of San Luis Potosí, Morelos and Tabasco in Mexico (Vargas *et al.*, 1946).

BIOLOGY AND MEDICAL IMPORTANCE. In Belize *S. ganalesense* bites man voraciously especially in lowland areas at the River Swasey and Bladen Branch, but there is no record of its biting habits from Mexico. The breeding grounds were difficult to find and the only two specimens were reared from pupae collected in two different types of river, one being 50 m wide and with medium flow and the other a small, slow flowing stream 2m wide and 10 cm deep. The pupae were attached to submerged grass. Further prospection in the headwaters of the river systems draining the eastern slopes of the Maya Mountains may reveal further breeding grounds, but access to the area is limited.

Simulium (*Psilopelmia*) *callidum* Dyar & Shannon

(Figs. 21, 33, 63, 64, 93, 105, 118, 130, 143, 176, 177, 202, 223, 243, 259).

Simulium callidum Dyar & Shannon, 1927: 16. HOLOTYPE ♀, MEXICO, Veracruz State, Córdoba, 16.iii.1908 (*F.Knab*) (USNM, cat no. 28677) [Examined.]

Simulium mooseri Dampf 1928: 127. SYNTYPES ♀♀, MEXICO: Oaxaca, Tiltepec [collection date unknown] (*Larumbe*) [Depository unknown] [Synonymy by Bequaert, 1934: 211]

FEMALE. General body colour orange. Body length (specimens preserved in alcohol) 2.9–3.8 mm ($\bar{x}$=3.4 mm, s.d.=0.27, n=6), wing length 2.5–2.6 mm ($\bar{x}$=2.5 mm, s.d.=0.06, n=5, wing width 1.2–1.4 mm ($\bar{x}$=1.4 mm, s.d.=0.09, n=5).

Head – dichoptic with red eyes; nudiocular area well developed (Fig. 21). Frons, clypeus and occiput black with silver pruinosity, frons and occiput with several long black hairs on lateral margins and on basal margin of frons. Mouthparts and maxillary palps dark brown. Antennae brown with scape, pedicel and basal third of first flagellomere yellow. Cibarium with well developed and highly sclerotised cornuae, less sclerotised in central region, lacking teeth in central trough but with 1+1 groups of fine teeth at base of cornuae (Fig. 33).

Thorax – scutum orange with numerous recumbent hairs, which appear brown or golden, depending on light direction. Scutal pattern varying in appearance with illumination. With anterior illumination, 1+1 submedian curved, silvery white bands extending from anterior margin of scutum for three quarters length of scutum and forming a lyre shape (Fig. 63). With posterior illumination scutal pattern consists of a broad median orange vitta running from anterior margin for three fourths of scutal length and 1+1 broad orange vittae lateral to these running from a point close to anterior margin for whole scutal length; humeri, parts of anterior margin, all of lateral margin and median section of posterior margin yellowish (Fig. 64). Humeri and lateral margins of scutum yellowish. Pleura yellowish brown with light grey pruinosity. Scutellum orange with recumbent brown hairs, postnotum brownish (sometimes orange) with greyish pruinosity. Costa of wing with many spines and fine hairs. Subcosta with 14–16 setae mainly in middle section, basal section of Radius with irregular row of setae; basal tuft of dark setae. Legs yellowish orange with brown hairs and dark brown bands on the following parts: fore leg tarsus, mid leg distal third of basitarsi and rest of tarsomeres, hind leg distal articulation of femora, distal half of tibiae and basitarsi and all tarsomeres (Fig. 93). Femora and tibiae of all legs without scales. Claws of

legs curved, each with basal tooth, well developed on hind leg. Halteres whitish.

Abdomen – tergites I and II yellowish with greyish pruinosity on posterior border of II; II–IX black (Fig. 105). Tergal plates well developed; sternites and genitalia black. Eighth sternite lightly sclerotised with 1+1 sub-median groups of about 20 setae of variable size; gonopophyses small, membranous, setose with slight sclerotisation on internal margins (Fig. 118). Cerci hemispherical, paraprocts large, sub-quadrangular with ventral, pointed prolongation (Fig. 130). Genital fork thin with well sclerotised stem and lateral arms; terminations of lateral arms less sclerotised with well developed anterior processes (Fig. 143). Spermatheca oval with no obvious external sculpturing and small groups of setae on internal surface; area of insertion of spermathecal duct membranous and about one fifth maximum width of spermatheca.

MALE. General body colour orange. Body length (specimens preserved in alcohol) 2.5–4.1 mm ($\bar{x}$=3.2 mm, s.d.=0.62, n=7), wing length 2.4–2.5 mm ($\bar{x}$=2.4 mm, s.d.=0.37, n=7), wing width 1.1–1.4mm ($\bar{x}$=1.1mm, s.d.=0.5, n=7).

Head – holoptic with eye facets dark red. Rest of head coloration as in female, except antennae brown.

Thorax – orange with even distribution of recumbent hairs that appear golden or brown depending on light direction. Scutum orange with 1+1 fine, pointed, white pruinose cunae extending from anterior scutal border for one third length of scutum with anterior light source (Fig. 176). With posterior light source cunae absent (Fig. 177). Lateral margin of scutum white pruinose. Scutellum orange with long, dark brown setae, postnotum orange with silver pruinosity along anterior border. Wing as in female, except Subcostal vein without setae. Leg coloration as in female (Fig. 93).

Abdomen – tergites orange and black, basal fringe with long orange hairs. Tergites I and II orange, tergites III–VIII mainly velvet black, although in some specimens this black coloration is confined to posterior margins of IV, VI, VII, VIII and lateral parts of tergite V with rest of segments brownish. Silver pruinose ornamentation: 1+1 sub-median areas on tergite VI and 1+1 lateral areas on tergites II, VI and VII. Genitalia black, sternites whitish; no sternal plates. Gonocoxite square; gonostyle sub-rectangular with curved apex with blunt spine (Fig. 202). Ventral plate lightly sclerotised with well developed basal arms and keel well developed with recumbent long hairs (Fig. 223). Median sclerite pyriform about twice as long as width at widest part with slit from apex running for about half its length (Fig. 223). Paramere with many well developed spines (Fig. 243).

PUPA. Cocoon length dorsally 2.9–3.7 mm ($\bar{x}$=3.3 mm, s.d.=0.24, n=13), ventrally 2.6–3.6 mm ($\bar{x}$=3.3 mm, s.d.=0.26, n=13), pupa length 2.6–4.7 mm ($\bar{x}$=3.8 mm, s.d.=0.53, n=13), gill length 2.5–3.6 mm ($\bar{x}$=3.1 mm, s.d.=0.34, n=12)

Cocoon light brown, slipper-shaped (Fig. 6), composed of lightly woven threads and with lightly reinforced anterior margin.

Gill light brown with eight forwardly directed branches. Gill filament branching very basal with filaments in vertical plane. Main trunk giving rise to three primary branches, all of which immediately bifurcate, dorsal secondary branches of dorsal and median primary branches then bifurcate again almost immediately (Fig. 259). Filaments fine, tapering slightly distally with spicules on surface, edges crenate and ends rounded; primary and secondary branches slightly wider.

Head with 2+2 frontal and 1+1 facial trichomes well developed and bifid (simple to trifid in frontal); surface of head covered with rounded tubercles, which are large on frontal region and smaller on sclerites covering eyes.

Thorax with 5+5 well developed simple to trifid trichomes; anterior surface of thorax covered with rounded tubercles. Abdominal tergite I with 1+1 simple hairs laterally; tergite II with 4+4 sub-median hooks, 2+2 setae anterior and between two outermost hooks and 2 simple setae on lateral margin; tergites III–IV with 4+4 simple hooks, 1+1 sub-median simple setae anterior to two outermost hooks and 1+1 spines on lateral margin; tergites V–VI with 1+1 irregular rows of six simple setae in middle area of segment and 1+1 lateral groups of spine combs in tergite VI; tergite VII with seta on lateral margin and 1+1 groups of spine combs antero-laterally; tergite VIII with single row of backwardly directed stout spines on median anterior margin and 1+1 lateral groups of fine spine combs on anterior margins and 3+3 simple setae on lateral margins; tergite IX with 1+1 strong, unbranched terminal spines and several rows of fine spine combs on anterior margin.

Abdominal sternite III with median band of small spine combs in central area of segment, sternite IV with 6+6 setae in irregular row along posterior margin and spine combs covering posterior margin of segment; sternite V with 2+2 strong spines, the outer being simple or bifid and inner with 2 branches with 1+1 patches of spine combs anterior to them, 1+1 lateral simple hairs in central part of segment; sternites VI–VII with 2+2 well developed bifid spines (sometimes outer ones simple) and 1+1 patches of spine combs anterior to them; sternite VIII with 1+1 patches of sub-median spine combs on anterior border.

TAXONOMIC DISCUSSION. Two female specimens collected by Frederick Knab in Córdoba in Mexico were described as *S. ochraceum* Walker by Malloch

(1914) in his revision of American Simuliidae largely based on material in the USNM. Subsequently, in an update on this work by Dyar & Shannon (1927) these two specimens were described as the new species *S. callidum*. We have examined the pinned holotype, which is missing the abdomen. A note on the label indicates that a slide was made and presumably this contains the abdomen. The external morphology of our material from Belize corresponded completely with the holotype. In 1928 Dampf described the new species, *S. mooseri*, based on 12 females collected in the onchocerciasis focus of Oaxaca, which he distinguished from *S. ochraceum* by leg colour and from *S. callidum* by the form of the genital fork. Bequaert (1934) synonymised *S. mooseri* with *S. callidum* and provided descriptions of the female, male and pupa. Since then various descriptions of the species have been made and these are listed in Coscarón (1987) and Coscarón *et al.* (1996), the latter providing descriptions and figures to all stages as part of a revision of the Neotropical species of the subgenus *Psilopelmia*. Coscarón *et al.* (1996) also described the most closely associated species, *S. pseudocallidum* Díaz Nájera, which they distinguished from *S. callidum* on characters in all stages. These are all relatively minor differences, which need more detailed investigation to determine whether they are intraspecific variations.

DISTRIBUTION. *Simulium callidum* was a relatively common species in Belize, in the higher areas of Mountain Pine Ridge (450–700 m) (Table 1, Material examined, Maps 2, 12). The species is largely confined to Central America being recorded in Belize, Colombia, Honduras, Costa Rica, Guatemala, Mexico, Panama, El Salvador and Trinidad (Coscarón, 1987; Coscarón *et al.*, 1996; Crosskey & Howard, 1996; Material Examined). The record for Venezuela in Crosskey & Howard (1996) stems from Vulcano (1981) and needs verification because Ramírez Pérez (1983) in his revision of the Simuliidae of Venezuela does not include this species for this country.

BIOLOGY AND MEDICAL IMPORTANCE. In Belize *S. callidum* was not collected biting man. Elsewhere in Central America it is largely zoophilic biting equines, cattle, sheep, goats, pigs, cats, weasels, chickens, turkeys and ducks (Dalmat, 1955), but will bite man mainly below the waist in relatively small numbers. Immature stages were found in slow flowing streams 1m wide to medium or fast flowing rivers, 30 m wide, with pupae and larvae attached to fallen leaves, grasses, pine needles or beds of submerged vegetation. Elsewhere, it breeds in small forest streams in all altitude ranges up to about 2500 m and is a secondary and fairly ineffective vector of human onchocerciasis in Mexico and Guatemala (Dalmat, 1955; Shelley, 1988a).

Simulium (Psilopelmia) haematopotum Malloch

(Figs. 6, 22, 34, 65, 66, 94, 106, 119, 131, 144, 178, 179, 203, 224, 244, 260, 261, 262)

Simulium haematopotum Malloch, 1914: 62. LECTOTYPE ♀, MEXICO: Veracruz State, Santa Lucrecia, La Oaxaqueña, x.1911, (*F.W.Urich*) (USNM, cat.no. 15414). [Examined.] **New designation.**

Simulium pseudohaematopotum Hoffmann, 1930b: 293. SYNTYPES ♀♀, MEXICO: Chiapas State, Pueblo Nuevo, vii.1930, (*C.C.Hoffmann*) ([Depository unknown, perhaps Institute of Biology, Universidad Nacional Autónoma de Mexico], cat. no. 18005). [Synonymy by Vargas, 1942a: 234.]

Simulium marathrumi Fairchild, 1940: 716. HOLOTYPE ♀, PANAMA: Panama Province, Rio Las Lajas, 20.xi.1939 (*G.B.Fairchild*) (MCZH). [Examined.] **New synonymy**.

Simulium boydi De León, 1945a: 76 (see TAXONOMIC DISCUSSION for details on first citation). HOLOTYPE pupa, GUATEMALA: Guatemala Department, Palín, Hacienda El Llano, 1944 (*R. De León & G.B. Fairchild*) [Depository unknown.] [Synonymy by Dalmat, 1951: 54.]

FEMALE. General body colour black. Body length (specimens preserved in alcohol): 1.5–2.2 mm ($\bar{x}$=1.9 mm, s.d.=0.24, n=25), wing length 1.6–2.0 mm ($\bar{x}$=1.7 mm, s.d.=0.09, n=21), wing width: 0.9–1.6 mm ($\bar{x}$=1.0 mm, s.d.=0.15, n=21).

Head – dichoptic with red eyes; nudiocular area slightly developed (Fig. 22). Frons, clypeus and occiput black with silver pruinosity, frons and occiput with several long black hairs on lateral margins and on basal margin of frons. Mouthparts and maxillary palps dark brown. Antennae brown with scape, pedicel and basal third of first flagellomere light brown. Cibarium with well developed and highly sclerotised cornuae, poorly sclerotised in central region and with several rows of sharp teeth of different sizes on protuberance either side of central trough (Fig. 34).

Thorax – Scutum black with large area of silver pruinosity with pattern not altered by light direction. Numerous, recumbent, brass-coloured hairs, which may appear brown depending on light direction. Scutal pattern consists of 1+1 broad, sub-median, silvery pruinose vittae adjacent to humeri and running from anterior margin to silver posterior margin; lateral margins silver pruinose (Figs. 65, 66). Scutellum black, silver pruinose with many recumbent brass-coloured bristles. Postnotum black with silver pruinosity. Pleura silver pruinose. Costa of wing with relatively sparse distribution of spines and fine hairs. Subcosta with no setae, basal section of radius without setae; basal tuft of dark setae. Legs mainly cream with dark brown

banding as follows: fore leg tarsi, mid and hind leg coxae, all of femora except basal articulation, distal half of tibiae, distal third of basitarsi (Fig. 94). Femora and tibiae of legs with elongate scales as in *S. metallicum*. Claws of legs curved without basal tooth. Halteres pale yellow.

Abdomen – tergites greyish black with silver pruinosity on lateral face of tergite II, tergites II–VI with central area velvet black (Fig. 106). Tergal plates well developed. Sternites and genitalia greyish black. Eighth sternite highly sclerotised except lightly sclerotised median area, with even distribution of about 20 mainly well developed setae except in central area; gonopophyses small, membranous and setose with internal margins sclerotised (Fig. 119). Cerci hemispherical, paraprocts sub-rectangular with two ventral protuberances (Fig. 131). Genital fork thin with long, sclerotised main stem with slight terminal knob part of which unsclerotised, terminations of lateral arms well developed with well developed, sclerotised anterior processes (Fig. 144). Spermatheca oval with no obvious external sculpturing and small groups of setae on internal surface; area of insertion of spermathecal duct membranous and about quarter maximum width of spermatheca.

MALE. General body colour black. Body length (specimens preserved in alcohol): 2.3–2.7 mm ($\bar{x}$=2.6 mm, s.d.=0.17, n=4), wing length – 1.7–1.9 mm ($\bar{x}$=1.8 mm, s.d.=0.08, n=4), wing width 1.0 mm ($\bar{x}$=1.0 mm, s.d.=0.02, n=4).

Head – holoptic with eye facets dark red. Rest of head coloration as in female.

Thorax – scutum velvet black with recumbent golden hairs. Scutal pattern varies with light incidence. With anterior light source 1+1 sub-median, silver pruinose, elongated triangles rounded posteriorly beginning on anterior scutal border and extending for about one third length of abdomen (Fig. 178). With light source posterior to specimen pruinose marks absent (Fig. 179). Humeri, lateral and posterior margins of scutum silver pruinose. Rest of thorax and wing as in female. Leg coloration as in female except mid and hind legs pale brown with cream articulations (Fig. 94).

Abdomen – tergites velvet black, basal fringe with long black hairs. Silver pruinose ornamentation as follows: tergite II completely silver except for median area; tergites V and VI with most of lateral margins silver; tergite VII with ventro-lateral margin silver. Genitalia and sternites brownish black; sternal plates poorly developed. Gonocoxite broadly rectangular; gonostyle rectangular with apico-lateral prolongation terminating in single large spine (Fig. 203). Ventral plate lightly sclerotised with well developed, curved basal arms and keel with recumbent, long hairs (Fig. 224). Median sclerite ovoid about twice as long as width at widest part (Fig. 224). Paramere with many (over 12), mainly well developed spines (Fig. 244).

PUPA. Cocoon length dorsally 2.1–2.8 mm ($\bar{x}$=2.3 mm, s.d.=0.2, n=9), ventrally 1.8–3.3 mm ($\bar{x}$=2.5mm, s.d.=0.17, n=9), pupa length 2.5–3.1 mm ($\bar{x}$=2.8 mm, s.d.=0.17, n=9), gill length 1.7–2.4 mm ($\bar{x}$=2.0 mm, s.d.=0.2, n=9).

Cocoon light brown, slipper shaped (as in Fig. 6), composed of lightly woven threads and with reinforced anterior margin.

Gill light brown with eight forwardly-directed branches arising from cephalothorax in a bunch. Gill filament branching mainly basal. Main trunk birfucates in about basal tenth of gill, dorsal primary branch again bifurcating in about basal sixth of gill. Dorsal secondary branch then bifurcates in about basal fourth of gill and the dorsal branch of this further bifurcates in about basal 5/12ths of gill. Ventral secondary branch bifurcates in about basal third of gill and dorsal branch of this further bifurcates in about basal half of gill. Ventral primary branch bifurcates in about basal third of gill (Fig. 260). In one specimen atypical branching was recorded where secondary branching on the dorsal primary branch was from approximately the same point in both gills (Figs. 261, 262). Filaments fine, tapering slightly distally with spicules on surface, edges crenate and ends rounded; primary and secondary branches slightly wider.

Head with 2+2 weakly to well developed simple frontal and 1+1 well developed bifid (sometimes simple) facial trichomes; surface of head either with few, sparsely distributed tubercles or covered with larger rounded tubercles, except in centre and apico-lateral areas of frontal region and smaller rounded tubercles on sclerites covering eyes.

Thorax with 5+5 poorly developed simple or bifid trichomes; anterior third of surface of thorax with only sparse distribution of tubercles or covered with rounded tubercles, larger in anterior half.

Abdominal tergite I with 1+1 simple hairs laterally; tergite II with 5+5 sub-median simple setae in row and 2+2 simple setae between and anterior to most lateral pair of setae in row, 1+1 fine setae in row on lateral margin; tergites III–IV with 4+4 simple spines and 1+1 sub-median simple setae anterior to and between two lateral most hooks and 1+1 fine lateral setae in II and 4+4 setae in IV; tergites V–VI with poorly developed spine combs on anterior margin, V with 2+2 fine sub-median setae in central part and VI with 1+1 lateral setae in central part; tergites VII–VIII with single row of backwardly-directed stout spines on median anterior margin and 1+1 lateral groups of fine spine combs on anterior margins; tergite IX with 1+1 unbranched terminal spines and several rows of fine spine combs on anterior margin. Abdominal sternite III with 1+1 sub-median bands of small spine combs in central area

of segment in which is group of 4+4 simple setae; sternite IV with 1+1 submedian, poorly developed simple spines, 1+1 patches of spine combs anterior to these; sternite V with 2+2 strong spines the outer being simple and inner bifid with 1+1 patches of spine combs anterior to them, 1+1 lateral simple hairs in central part of segment; sternites VI–VII with 2+2 well developed spines (inner bifid, outer simple) and 1+1 patches of spine combs anterior to them; sternite VIII with 1+1 patches of sub-median spine combs on anterior border.

TAXONOMIC DISCUSSION. Malloch (1914) based his description of the female on a series of syntypes (cotypes) collected biting man in Mexico. One pinned female of this series remains in the USNM. It has been examined, is in excellent condition and has been selected as lectotype. Malloch also referred to a specimen collected by E.A.Schwarz from Cayamas, Cuba as belonging to the type series. We have examined two pinned females in the USNM collection (one labelled as cotype) with these details and have identified both as *S. quadrivittatum* Loew. Hence the 'cotype' is not part of the type series of *S. haematopotum*. Following Malloch's description of the female (1914) *S. haematopotum* has been described in all its stages by various authors. Major source references for these publications as well as descriptions of this species are: Coscarón (1987, 1991), Coscarón *et al.* (1993, 1996), Dalmat (1955), Vargas (1945), Vargas & Días Nájera (1957).

In 1940 Fairchild described the simuliid fauna of Panama and included an anthropophilic species under the name *S. haematopotum*, but was uncertain of his identification (especially with regard to the morphology of the genital fork and claws) as he had been unable to consult Malloch's original description. He mentioned that a previous publication by Dunn listed the same species in Panama as *S. quadrivittatum* Loew. Later, Vargas (1942b) gave the name *S. fairchildi* to Fairchild's material based on the difference in genital fork morphology of the Panama specimens with true *S. haematopotum* from Mexico. Fairchild (1943) later placed *S. fairchildi* as a junior synonym of *S. quadrivittatum*.

Hoffmann (1930b) collected six species, of which two were described as new, in the region of the onchocerciasis zone in Chiapas State in Mexico. He based his description of one of these new species, *S. pseudohaematopotum,* on biting females collected in the coastal plains below the Sierra de Soconusco. The genitalia of the new species are figured and short notes on colour and wing venation are presented. No indication is given as to whether a holotype was selected, so we presume the material to have the status of syntypes. Vargas (1942a) synonymised this name with *S. haematopotum* based on Hoffman's description as none of Hoffmann's specimens was located.

In 1943 De León provided preliminary descriptions of five new species collected in 1940 from the onchocerciasis zones (figured in Dalmat, 1955) of western Guatemala at altitudes of up to 3000 m, referring to them as *S. roblesi* and species B, C, D, E. De León (1945a) described these species in more detail and those referred to by letters were given names. Included in this paper were five more new species collected by León and Fairchild in an expedition to other localities in the same area. One of these species, *S. boydi*, was described from the pupa and females were recorded as biting man in high numbers. De León regarded this as a new species after consulting Pinto (1932) and likened the pupal gill of *S. boydi* to that of *S. subpallidum* from South America, being aware at the time of anthropophilic *S. haematopotum* occurring in parts of western Guatemala. Dalmat (1951) compared topotypes of *S. boydi* with *S. haematopotum* and found then synonymous, an action accepted by subsequent authors. Some confusion exists over the date of the original description of *S. boydi*. Dalmat (1951, 1955) gives the publication date as 1944 in the *Boletin Sanitaria de Guatemala 52:66–77*. The same reference, but with the year 1945, is given by Coscarón *et al.* (1993, 1996) and Crosskey & Howard (1996). Coscarón (1987) further added that a separate of 12 pages of this paper was issued. De León (1946) in a paper written in 1945 on the ecology of the area in which these species were collected cites only the separate with the publication date of 1945. We have seen the separate, which is dated 1945, has 12 pages and was written in January 1945 as well as the original journal, which was also published in January 1945.

Reared adults and pupae were described by Fairchild (1940) from Panama as *S. marathrumi*, a species that he compared with *S. paraguayense* Schrottky and *S. lutzianum* Pinto, both from South America. Coscarón *et al.* (1993, 1996) considered *S. marathrumi* to be closely related to *S. haematopotum*, the two being distinguished by body size and leg coloration. They would not regard the species as conspecific until they had examined larvae and pupae of *S. marathrumi*. We have now examined the primary type specimens of both species, other specimens in the type series of *S. marathrumi* and reared *S. marathrumi* from Panama and conclude that *S. marathrumi* is a junior synonym of *S. haematopotum*. The holotype female consists of a pinned thorax in poor condition and a preparation of the abdomen showing the paraprocts and cerci, eighth sternite and genital fork also attached to the pin. The two male paratypes, one pinned and the other dissected are conspecific with *S. haematopotum*. Vulcano (1967) incorrectly cites the type locality as Lajas River, Chorreras Falls. Both localities are in Panama Province, Chorrera Falls being on the R. Caimito near Chorrera from which man-biting paratypes were collected, while the type locality is Rio Las Lajas.

Coscarón *et al.* (1996) revised the subgenus

Psilopelmia and provided keys and descriptions for distinguishing *S. haematopotum* from closely related species. They presented differences in adult genitalia and pupal gills, which serve to distinguish the superficially similar two species *S. haematopotum* and *S. veracruzanum*. We include figures of the female scutal and abdominal patterns of a female *S. veracruzanum* (Figs. 69, 70, 107) and the lectotype female of *S. haematopotum* (Figs. 67, 68) as they are similar, both anthropophilic and were confused by Lewis in Belize. The specimen of *S. veracruzanum* from INDRE is labelled as a paratype and was collected by F. Reyes at Escamela in Veracruz State on 31.i.1948. It is not in the paratype series because the specimen was collected in 1948 after the publication of *S. veracruzanum* as a new species in 1946 by Vargas *et al.*, but was recognised by Vargas & Díaz Nájera, 1957 as true *S. veracruzanum*. Another error in the type series stemming from the original description of *S. veracruzanum* (Vargas *et al.*, 1946) is the reference to the type locality as Río Sedeño, Veracruz State. The data on the male holotype slide label indicate Barranca San Miguel, Fortín as the type locality. The scutal patterns were not figured in Coscarón *et al.* (1996) because other morphological differences enable a distinction to be made between the two species. The basic scutal pattern is the same except in the following: in *S. haematopotum* the lateral vittae converge posteriorly while in *S.veracuzanum* they are parallel to the median vitta. In *S. veracruzanum* 1+1 beige, intervittal cunae on the anterior scutal border (anterior light source Fig. 69) merge with the beige (becomes slightly silver pruinose) humeri and lateral borders; cunae are more white pruinose on a silver pruinose background with a posterior light source (Fig. 70). These cunae are absent in *S. haematopotum* (Figs. 65, 66). Additionally, the lateral vittae of *S. veracruzanum* reach the posterior edge of the scutum whereas in *S. haematopotum* all three vittae are of the same length and terminate before the posterior border of the scutum. The abdominal pattern of both species consists of a median velvet black rectangular patch on tergites II–VI (reduced in tergite II in *S. veracruzanum* (Fig. 107) and sometimes dispersed laterally in *S. haematopotum* (Fig. 106)), but in *S. veracruzanum* each segment has 1+1 distinct, sub-median black patches on tergites III–VII giving a chequer board pattern. In *S. haematopotum*, these patches are less discrete and only occur on tergites III and IV and sometimes V. Also, the scutellum of *S. veracruzanum* is cream compared to the brown or black scutellum of *S. haematopotum* and the legs of *S. veracruzanum* are mainly cream except for distal articulations of most leg parts, except the basitarsi of mid and hind legs and tarsi of fore legs, which are black.

DISTRIBUTION. Lewis & Garnham (1960) did not record *S. haematopotum* in Belize, but one specimen was identified provisionally as *S. veracruzanum*. Only the genital fork, eighth sternite and gonopophyses, abdomen and parts of a tarsus are on the slide. The genital fork is of *S. haematopotum* and the specimen has been recorded as such in the Material Examined. The record in Crosskey & Howard (1996) of this species occurring in Belize is based on this misidentified specimen and so *S. veracruzanum* is not now regarded as being present in this country. In Belize *S. haematopotum* is widespread throughout the country with the most dense breeding populations occurring in rivers draining the east of the Maya Mountains (Table 1, Material Examined, Maps 2, 13). This species also occurs in other countries in Central America and the Caribbean: Cuba, Dominican Republic, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Puerto Rico and Panama (Material Examined; Bradt, 1932; Coscarón, 1987; Coscarón *et al.*, 1993, 1996; Crosskey & Howard, 1996; Maes, J-M., 1990; Pinto, 1932; Travis *et al.*, 1974; Rubstov & Garcia Avila, 1972; Vulcano 1967; Vargas 1945). Although earlier papers and catalogues cite Cuba in the distribution list based on Malloch's misidentification of *S. quadrivittatum* (as *S. haematopotum*), subsequent work by Rubtsov & Garcia Avila (1972) showed the presence of this species in that country. Other countries are also listed in the most recent world inventory of species (Crosskey & Howard, 1996) and in some of the cited works above, but are believed by us to be based on misidentifications. These are Colombia, Guyana, Surinam and Venezuela. Muñoz de Hoyos (1994) in her catalogue of the Simuliidae of Colombia included *S. haematopotum* based on Coscarón (1987) [Coscarón *et al.*, 1993 followed Vulcano, 1967] and Maes (1990), who gave no collection localities. It is probable that this name has been given as a misidentification of *S. sanguineum* or the less common *S. quadrivittatum* (presence in Colombia recorded in Shelley *et al.*, 1989), the two most closely similar (and often confused) man-biting species that occur in Colombia. The reference to Guyana (as British Guiana) dates back to Vargas (1945) [see Coscarón *et al.*, 1993], who referred to specimens in the BMNH [which are actually *S. oyapockense s.l.* and/or *S. roraimense*]. In the case of Venezuela the record probably dates back to Iriarte's work on simuliids in the 1940s, when he recorded the presence of *S. haematopotum* in Bolivar State (Iriarte, 1983). This author was cited for the inclusion of *S. haematopotum* in the list of simuliid species of Venezuela by Briceño Iragorry & Ortiz (1957). The most recent and comprehensive work of Ramírez Pérez (1983) does not list this species as being present in Venezuela. The species recorded by Iriarte (1983) is almost certainly a species of the *amazonicum* group, since members of this group are recorded in Bolivar State. The record for Surinam in Crosskey & Howard (1996) was based on Vulcano (1981) [personal communication, Dr R.W.Crosskey].

The source for Vulcano's record is unknown, but the species involved is almost certainly *S. oyapockense s.l.* or *S. roraimense*. The fauna of Surinam is not well known but its juxtaposition to Brazil, French Guiana and Guyana where these two species of the *amazonicum* group occur (Shelley *et al.*, 1997) makes it almost certain to be one of them.

BIOLOGY AND MEDICAL IMPORTANCE. *Simulium haematopotum* was a common species in Belize where it was frequently found biting man especially in the south-east along with *S. ganalesense*. Pupae and larvae were collected from slow flowing streams of 1 cm deep and 10 cm wide to medium or fast flowing rivers of 25 cm deep and 50 m wide, always attached to fallen leaves, submerged grasses or any other vegetation, especially species of the family Podostemaceae. Elsewhere in Central America it bites man and dogs (Dalmat, 1955; Fairchild 1940; Hoffmann 1930b; Malloch 1914; Travis *et al.*, 1974). *Simulium haematopotum* was recorded as a possible vector of carate or mal del pinto by León & Wygodzinsky (1953). In Guatemala it is a secondary vector of human onchocerciasis (Shelley, 1988a; Tada,1987)

Simulium (*Psilopelmia*) *ochraceum* Walker complex

(Figs. 6, 23, 35, 71, 72, 73, 74, 95, 108, 120, 132, 145, 180, 181, 204, 225, 245, 263).

Simulium ochraceum Walker, 1861: 332. NEOTYPE ♀, MEXICO: Chiapas State, Huixtla, Morelos, 30.vi.1985 (*A.L. Millest*) (BMNH). **New type designation**.

Simulium bipunctatum Malloch, 1912: 650. HOLOTYPE ♀, PERU: Rio Charape, 13.ix.1911 (*C. H. T. Townsend*) (USNM, cat. no. 15305) [Examined.] [Synonymised with *S. dinellii* Joan by Knab, 1913: 155; revalidated by Coscarón, 1985: 320.] **New synonymy**.

Simulium antillarum Jennings, 1915: 200. LECTOTYPE ♂, VIRGIN ISLANDS: St Croix Island, 1.5 miles west of West End, Frederiksted, 24.xi.1913 (*A. H. Jennings*) (USNM, cat. no. 19997). [Lectotype designation by Stone (1969:313).] [Synonymy by Shelley *et al.*, 1989: 92.] **New synonymy**.

Simulium wolcotti Fox, 1953: 138. HOLOTYPE ♂, PUERTO RICO: Henry Barracks, near Cayey, 1950 (*I. Fox*) (STMPR). [Synonymy with *S. antillarum* Jennings by Stone, 1969: 313; synonymy with *S. bipunctatum* by Shelley *et al.*, 1989: 92.] **New synonymy**.

Simulium pseudoantillarum Ramírez Pérez & Vulcano, 1973: 379. SYNTYPES 1♀, 1♂, VENEZUELA: Monagas State, San Antonio de Maturin, [no collection date] (Ramírez Pérez & Vulcano) (DDSV). [Synonymy by Shelley *et al.*, 1989: 93.] **New synonymy**.

FEMALE. General body colour orange. Dimensions by country. BELIZE: body length (pinned) 2.1 mm, wing length 2.1 mm, wing width 0.75 mm, n=1. MEXICO: body length (specimens preserved in alcohol) 1.8–3.4 mm ($\bar{x}$=2.5 mm, s.d.=0.41, n=15), wing length 1.7–2.2 mm ($\bar{x}$=1.8 mm, s.d.=0.16, n=14), wing width 0.7–1.1= mm ($\bar{x}$= 0.8 mm, s.d.=0.11, n=14). ECUADOR (specimens preserved in alcohol): body length 2.1–3.5 mm, wing length 1.7–2.7 mm, wing width 0.9–1.2 mm, n=30.

Head – dichoptic with red eyes, nudiocular area well developed (Fig. 23). Frons, clypeus and occiput black with silver pruinosity. Mouthparts black. Antennae ranging from orange with distal third to half dark brown (Ecuador), to dark brown with basal 3 segments orange. Cibarium with anterior margin sclerotised, central trough armed with several irregular rows of small teeth, 1+1 groups of teeth forming a protuberance on each side of trough that continue to the sclerotised, well developed cornuae (Fig. 35).

Thorax – orange with lateral margins yellowish. With light source anterior 1+1 yellowish bands running parallel to anterior scutal margin from a sub-median position to the lateral margins in anterior eighth of scutum. Scutum with pair of sub-median, silvery white, comma-shaped marks in anterior third of scutum commencing behind ends of yellow bands. These marks vary in length being shorter in populations from Guatemala and Mexico, but longer in Brazil, Ecuador and the Caribbean Islands (Figs. 71, 73). With light source posterior comma-shaped marks absent (Figs. 72, 74). Paranotal folds orange/brown in fresh specimens, often becoming dark brown to black in preserved material. Scutum with numerous adpressed black setae lying singly. Pleural region varying from light orange to mid brown with faint silver pruinosity. Scutellum orange with erect black bristles on posterior margin; postnotum orange (Brazil, Colombia, Dominican Republic, Jamaica, Monserrat, Panama, Puerto Rico, Venezuela and most Ecuador specimens) to brown, and sometimes black (Mexican specimens). Subcostal wing vein with line of 5–10 setae in middle section, basal section of Radius with one (rarely two irregular) rows of setae. Costal base tuft dark brown. Leg coloration is variable (Fig. 95). In specimens from Mexico and Guatemala and Panama (one) legs are dark brown, and in some cases with darker distal articulations on the tibiae and femora. In Brazil, Dominican Republic, Jamaica, Puerto Rico, Montserrat, Venezuela, and Ecuador usually fore leg coxae, trochanters and femora of all legs orange to light brown; coxae of mid and hind legs light brown on anterior half, dark brown on posterior half; tibiae and tarsi of all legs dark brown. Mid and hind leg femora and tibiae with darker distal articulations. Exceptionally, legs are dark brown. In Colombia both may be found in the same locality. Claws curved with large basal tooth. Proportions of

legs as in Fig. 95. In some specimens from Mexico the hind leg tibiae are more slender. Halteres yellow with light brown stems.

Abdomen – tergites from yellowish orange to brown depending on age of specimen and whether it has blood fed; older blood fed specimens tend to become dark brown. Tergites I–IV usually mottled light brown and yellow but can be yellowish orange, particularly in reared material, occasionally mid brown; tergite V usually matt grey (in most specimens from Ecuador) to matt black (in specimens from Mexico); tergites VI–IX dull mottled mid and light brown but sometimes completely shiny brown or black (Fig. 108). Tergal plates well developed and generally light brown, sometimes dark brown. Sternites and genitalia orange to light brown becoming dark brown in preserved specimens. Eighth sternite usually lightly sclerotised with 20–24 setae on each side; gonopophyses small, membranous with minute hairs on inner margin (Fig. 120). Cerci hemispherical, heavily sclerotised; paraprocts more lightly sclerotised especially in pronounced ventral extension (Fig. 132). Genital fork slender generally with terminal knob and well developed, triangular anterior processes (Fig. 145). Spermatheca, oval, sclerotised, with surface covered in regular rounded depressions and spicules of inner surface randomly arranged; area of insertion of spermathecal duct membranous and between a third and a quarter as wide as maximum width of spermatheca.

MALE. General body colour orange. GUATEMALA: body length (pinned) 1.7 mm, wing length 1.9 mm, wing width 0.9 mm, n=1. ECUADOR: body length (specimens preserved in alcohol) 2.0–3.4 mm (n = 15), wing length 1.8–2.4 mm (n = 15), wing width 0 9–1. 0 mm (n = *15*).

Head – holoptic with red eyes. Clypeus black with silver pruinosity. Rest of head coloration as in female.

Thorax – coloration and hairing of scutum, pleural region, scutellum and postnotum as in female (Figs. 180, 181). Subcostal wing vein bare or with variable number of setae (1–7) in central portion, basal section of Radius with a single row of setae. Leg (Fig. 95) and haltere coloration as in female.

Abdomen – tergites I–IV mottled orange and light brown; tergites V–IX and genitalia light to dark brown; basal tuft of light orange hairs. Silver ornamentation as follows: tergites VI and VII with a pair of sub-median silver pruinose patches, anterior margin of tergite II and all of tergite IX faintly pruinose. Sternites I–IV light orange, V–IX dark brown; sternal plates well developed only on segments V–VIII. Genitalia orange to dark brown. Gonocoxite longer than wide; gonostyle same length as length of gonocoxite, curved and conical with apical spine (Fig. 204). Ventral plate (Fig. 225) with reduced and lightly sclerotised basal arms and small keel; hairs long and covering most of ventral plate. Median selerite (Fig. 225) slightly longer than wide with apical incision. Paramere as in Fig. 245 with few well developed, mainly apical spines and several smaller spines.

PUPA. BELIZE: cocoon length dorsally (preserved in glycerine), 3.0 mm (n = 1), ventrally 2.5 mm, pupa length 2.6 mm, gill length 1.9 mm. GUATEMALA: gill length (on slide) 2.5 mm (n = 1). ECUADOR: cocoon length dorsally – 2.1–3.2 mm, ventrally 2.8–4.2 mm, length of pupa 2.0–3.3 mm, gill length 2.5–3.2 mm (n = 38).

Cocoon slipper-shaped (as in Fig. 6), dark brown; rim of aperture dark brown, reinforced and usually without median protuberance. Cocoon composed of thick threads producing an open weave, particularly laterally at point of adhesion to substrate.

Gill light brown with eight forwardly directed slender filaments arranged irregularly in vertical plane (Fig. 263). Main trunk giving rise to three primary branches, ventral with two filaments and median and dorsal each with three filaments. Filaments arise basally on all primary branches; filaments slender with crenated margins and rounded distally, their surfaces covered with fine spicules.

Head with 2+2 frontal and I+I facial bifid or trifid well developed trichomes; surface of head with sparsely distributed platelets.

Thorax with 5+5 trichomes on anterior border, each with 2–5 branches, 1+1 postero-dorsal and 1+I ventral unbranched trichomes. Surface of thorax with few tubercles (Mexico) or covered with tubercles mainly concentrated around dorsal region (Ecuador).

Abdominal tergites II–IV with 4+4 simple hooks, more weakly developed on segment II, VI–IX with spine combs on anterior margins, tergite IX with 1+1 strong, unbranched spines; sternite IV in female with 2+2 simple hooks, in male reduced to fine setae, sternites V–VII with 2+2 simple to bifid hooks; I+1 patches of spine combs on postero-lateral borders of sternites IV–VIII.

TAXONOMIC DISCUSSION. The female of *S. ochraceum* was described by Walker in 1861 from the collection of Diptera of W.W.Saunders. No indication of the number of specimens examined was made nor details of the type locality other than Mexico. The collection of Saunders was deposited in the BMNH, but no trace of *S. ochraceum* has ever been found. A more detailed description of the female was given by Malloch (1914) from two females collected by Knab in Córdoba, Mexico, but these specimens were actually of *S. callidum* (see Taxonomic Discussion of *S. callidum*). The modern concept of the female of this species dates back to Dyar & Shannon (1927). It is a well known species biting man in high numbers and because of its status as a vector of *Onchocerca volvu-*

lus it has been well studied. Because of its similarity to other Neotropical species and the possibility that one or more species are its junior synonym(s) we have designated a neotype female. This specimen is in good condition, is pinned and was collected in 1985 biting man on the periphery of the South Chiapas onchocerciasis focus in Mexico. We have selected this locality because the species is the primary vector of onchocerciasis in Mexico and Millest carried out intensive studies in the area where only cytospecies A of the *ochraceum* complex was recorded. Future work on this species complex may proceed to the point where cytotypes are regarded as good species and given names, in which case *S. ochraceum* would refer to cytotype A of the complex. This action conforms with Article 75 of the International Code of Zoological Nomenclature (fourth edition) (2000). Coscarón (1991) includes this species in the subgenus (*Ectemnaspis*), but we are following Crosskey & Howard (1996) and maintaining it in *Psilopelmia.*

Shelley *et al.* (1989) reviewed the taxonomy of *S. bipunctatum* and questioned the distinctness of this species from *S. ochraceum.* The two species are only distinguished on leg and postnotum coloration, which can vary intraspecifically. These authors did not at that point regard the two species as synonymous, preferring to await further examination of material using integrated taxonomic methods. A comparison of the neotype of *S. ochraceum* and a paratype of *S. bipunctatum* showed the following differences; in *S. ochraceum* the postnotum is brown as are the legs, whereas in *S. bipunctatum* the postnotum is orange and the legs, except for the tarsi, are dark orange. The latter specimen is old and discoloured. However, variation in these characters was noted in the present description. Generally Mexican and Guatemalan specimens correspond to the neotype, whereas in the Caribbean Islands and South America the coloration of the paratype of *S. bipunctatum* predominates, although combinations of coloration are seen involving the postnotum and legs. In conclusion we have found insufficient reasons to maintain *S. bipunctatum* as a valid species and therefore synonymise it with *S. ochraceum.* Coscarón (1991) noted the similarity between *S. scutellatum* Lane & Porto described from man-biting females in southern Brazil and *S. bipunctatum* and *S. ochraceum*, but declined from making any synonymy until other stages could be obtained for examination.

In 1983 Hirai & Uemoto showed that *S. ochraceum* is a species complex in Central America consisting of three cytotypes, A, B and C. Millest (1989) found all three cytotypes in Mexico, but only cytotype A in the Soconusco or South Chiapas focus. Adult females collected by Millest at the same time and at one of the localities of the cytotyped larvae were the series from which the neotype was selected. Preliminary studies showed that *S.ochraceum s.l.* can be distinguished from other species using both isozyme and molecular techniques (Agatsuma *et al.*, 1986, 1993; Tang *et al.*, 1996), and the latter needs to be used more fully for defining the complex.

DISTRIBUTION. In Belize only a single female, reared from a pupa, of *S. ochraceum s.l.* was collected in the Maya Mountains (Table 1, Material Examined, Maps 2, 14). Taking into account the synonymy of *S. bipunctatum* with *S. ochraceum* this species is now found in the following countries: Belize, Brazil, Colombia, Costa Rica, Cuba, Dominica, The Dominican Republic, Ecuador [including Galapogos Islands], French Guiana, Guatemala, Jamaica, Mexico, Montserrat, Panama, Peru, Puerto Rico, St. Croix, Trinidad and Venezuela (Crosskey, 1999; Crosskey & Howard, 1996; Coscarón, 1987; Hamada & Fouque, 2001; Shelley *et al.*, 1989; Material Examined.). Millest found all three cytotypes in Mexico, each associated with a different onchocerciasis focus: cytotype A in the South Chiapas focus, cytotype B in the Oaxaca focus and cytotype C in the North Chiapas focus. Only cytotypes A and C have been found in Guatemala and cytotype A predominates in the main Yepocapa onchocerciasis focus (Procunier, 1989).

BIOLOGY AND MEDICAL IMPORTANCE. *Simulium ochraceum s.l.* will bite man to varying degrees in different localities (Shelley, 1988a; Shelley *et al.*, 1989 [as *S.bipunctatum*]). In Central America it is largely anthropophilic [see Dalmat (1955) for most comprehensive study of biology of *S.ocharaceum s.l.* in Guatemala] while in Ecuador and in the majority of the Caribbean Islands it is mainly zoophilic, only rarely coming to bite man. It is, however, markedly anthropophilic in the Upper Amazon region of Brazil along the R. Vaupes, but only occasionally bites man (possibly due to small fly populations rather than zoophilic tendencies) farther north in the Amazonia onchocerciasis focus of Brazil and Venezuela. In parts of Guadeloupe and the Galapagos Islands of Ecuador it can also be a biting nuisance (Dr C. Causton – www.darwinfoundation.org.). In Guatemala it is also recorded as biting horses, mules, donkeys, cattle, sheep, goats, pigs, dogs, foxes, cats, and tayras, chickens, turkeys, ducks and pigeons (Dalmat, 1955). This species is the primary vector of human onchocerciasis in Guatemala and Mexico and may be responsible for sporadic transmission of the disease in the onchocerciasis foci of mainland Ecuador. The single female specimen of *Simulium ochraceum s.l* was reared from a pupa collected in Mountain Pine Ridge at 450 m collected in a small, slow flowing stream 1m wide and 10cm deep attached to fallen leaves. Elsewhere, *S. ochraceum s.l.* typically breeds in shaded, slow or fast flowing streams up to an altitude of 1200 m throughout the year, but has been recorded in larger rivers (up to 20 m wide) in Brazil (Shelley, 1988a; Shelley *et al.*, 1989

[as *S. bipunctatum*]). The biology of *S.ochraceum s.l.* has been studied in Guatemala, particularly with reference to transmission and control of onchocerciasis through vector larviciding (Tada, 1983, 1985, 1987). Little is known about its habits in terms of cytotype. From Millest's work (1989) it was recorded that there was a preference amongst larvae of different cytotype for different types of stream in terms of size, temperature and pH. It is also apparent from this work that all three cytotypes transmit *O. volvulus.*

Simulium (Psilopelmia) quadrivittatum Loew

(Figs 6, 24, 36, 75, 76, 96, 109, 121, 133, 146, 182, 183, 205, 226, 246, 264, 265).

Simulium quadrivittatum Loew, 1862: 186. LECTOTYPE ♀, CUBA, [Collection date unknown] (*Gundlach*) (MCZH, cat. no. 12533). [Lectotype designation by Shelley *et al.*, 1989.] [Examined.]

Wilhelmia mallochi Enderlein 1925: 208. LECTOTYPE ♀, COSTA RICA: La Palma, 6.v. [no year cited] (*Biolley*) (USNM, cat. no. 8998, type no. 41595). [Lectotype designation by Shelley *et al.*, 1989.] [Examined.] [Synonymy by Vargas, 1945: 189.]

Simulium fairchildi Vargas, 1942a: 458. LECTOTYPE ♀, PANAMA: Juan Mina Station, Rio Chagres, 8. xi. 1939 (*G. B. Fairchild*) (MCZH). [Lectotype designation by Shelley *et al.*, 1989.] [Examined.] [Replacement name for *S. haematopotum* Malloch *sensu* Fairchild, 1940.] [Synonymised with *S. quadrivittatum* by Fairchild, 1943: 574.]

FEMALE. General body colour black. Body length (specimens preserved in alcohol) 2.0–2.7 mm ($\bar{x}$=2.4 mm, s.d.=0.23, n=12), (pinned) 1.6 mm (n=1), wing length 1.6–2.1 mm ($\bar{x}$=1.9 mm, s.d.=0.11, n=13), wing width 0.9–1.1 mm ($\bar{x}$=1.1 mm, s.d.=0.07, n=13).

Head – dichoptic with red eyes; nudiocular area well developed (Fig. 24). Frons, clypeus and occiput black with silver pruinosity. Mouthparts dark brown. Antennae orange-brown. Cibarium with sclerotised posterior margin armed with teeth: median area of margin concave with 3–5 stout teeth; 1+1 sub-median groups of about six well developed teeth with the central being longer and up to tri-cusped; cibarium between these teeth and cornuae occupied by three to five smaller teeth; cornuae well developed and sclerotised (Fig. 36).

Thorax – scutum velvet black with silver pruinose ornamentation, which varies in form depending on angle of illumination. With light source anterior to specimen silver ornamentation as follows: 1+1 sub-median bands narrowing posteriorly and running from the anterior scutal border and coalescing with the silver pruinose posterior border, a pair of dull grey cunae in form of equilateral triangles present in anterior section of these bands; a pair of sub-lateral parallel bands beginning at the golden, pruinose humeri and extending to posterior pruinose margin of scutum (Fig. 75). With light source posterior to specimen grey cunae become silver and merge with sub-median bands, the rest of the pattern being identical to that seen with anterior light source (Fig. 76). Paranotal folds black with silver pruinosity. Scutum with numerous adpressed, golden hairs. Pleural region dark brown with faint silver pruinosity. Scutellum velvet black with uneven row of long black bristles on posterior border and 1+1 postero-lateral groups of these bristles. Postnotum black with grey pruinosity. Subcostal vein of wing usually bare, but sometimes with up to two hairs on median section and more rarely a single hair at base of vein amongst sensilla; basal section of Radius bare. Basal tuft of dark hairs. Legs dark brown with coxae lightly grey pruinose; distal tip of femur and basal tip of tibia light brown at articulation on fore leg; distal tip of femora of mid leg and basal half of basitarsi and second tarsomeres cream; basal articulation of tibiae, basal half to two thirds of basitarsi and basal half of second tarsomeres of hind leg cream; proportions of legs as in Fig. 96. Femora and tibiae of all legs and trochanters of fore and hind legs with numerous scales scattered amongst hairs. Claws curved with basal tooth. Halteres bright yellow with light brown base.

Abdomen – tergites black. Tergal plates slightly developed. Tergite I velvet black, sometimes with faint silver pruinosity in central part; tergite II black with silver pruinosity; tergites III–V velvet black with posterior margins faintly silver pruinose; tergites VI–IX shiny black (Fig. 109). Sternites and genitalia dull black. Eighth sternite sclerotised with 1+1 groups of 8–10 setae, gonopophyses large, sub-quadrangular with numerous minute setae (Fig. 121). Cerci hemispherical, paraprocts small and sub-rectangular (Fig. 133). Genital fork stout with well sclerotised stem, expanded arms and well developed lateral wings with sclerotised anterior processes (Fig. 146). Spermatheca oval, sclerotised with no external sculpturing and spicules of inner surface arranged in groups of three; area of insertion of spermathecal duct membranous and about one third maximum width of spermatheca.

MALE. General body colour black. Body length (specimen only available from Ecuador) 2.6 mm (specimen preserved in alcohol), wing length 1.65 mm, wing width 0.9 mm.

Head – holoptic with dark red eyes. Clypeus black with silver pruinosity. Rest of head coloration as in female.

Thorax – with light source anterior to specimen scutum velvet black with 1+1 sub-median, silver cunae extending from anterior scutal border for about two-

thirds of its length (Fig. 182). With light source posterior to specimen tails of cunae absent (Fig. 183). Posterior border and anterior three-fourths of lateral border of scutum silver pruinose. Scutum with adpressed golden hairs. Paranotal fold velvet black. Coloration and setation of pleural region, scutellum and postnotum as in female. Subcostal vein and basal section of Radius bare. Leg coloration as in females (Fig. 96). Scale distribution on legs as in female. Haltere coloration as in female.

Abdomen – tergites velvet black, basal fringe of long black hairs. Silver pruinose ornamentation as follows: tergite II completely silver; tergites III, V and VI completely silver except for median dark patch. Sternites and genitalia dark brown, sternal plates not examined through lack of material. Gonocoxite slightly longer than wide; gonostyle sub-triangular, about half length of gonocoxite, with sub-terminal, rounded spine (Fig. 205). Ventral plate as in Fig 226, with highly developed, lightly sclerotised basal arms and poorly developed keel; hairs long and restricted to keel. Median sclerite slightly pyriform with small apical incision (Fig. 226). Paramere as in Fig. 246, with several well developed distal spines.

PUPA. Cocoon length dorsally 1.8 mm, ventral 2.6 mm (n=2), pupa length 3.0–3.1 mm (n=2), gill length 2.6–4.5 mm (n = 2).

Cocoon slipper-shaped as in Fig. 6, dark brown, opaque; rim of aperture dark brown, reinforced and sometimes with dorsal protuberance. Cocoon surface of thin, densely interwoven fibres.

Gill mid brown with eight, forwardly directed, long, slender filaments; primary branches arise in vertical plane with filaments arranged in horizontal plane. Main trunk of gill giving rise to three primary branches, inner (= ventral) with two filaments and median and outer (= dorsal) each with three filaments: inner branch with bifurcation at basal sixth of gill, median branch with first bifurcation at basal sixth and second at basal third, outer branch with first bifurcation at basal tenth and second bifurcation at basal sixth of gill (Fig. 264). An atypical form showed the secondary branches from the median primary branch arising from the same point (Fig. 265). Filaments slender with crenate margins and rounded distally, their surfaces covered with fine spicules.

Head with 2+2 bifid frontal and 1+1 simple well developed facial trichomes; surface of head glabrous with few platelets.

Thorax with 5+5 well developed, bifid, antero-dorsal trichomes. Surface of thorax with few tubercules.

Abdominal tergite II with a line of 4+4 fine hairs; tergites III–IV with 4+4 simple hooks; tergite IX with 1+1 well developed spines; tergites VI–IX with row of well developed spine combs on anterior margins of segments; sternite IV with 2+2 simple or bifid well developed hooks; sternites V–VII with 2+2 bifid or trifid hooks; sternite VIII with 1+1 antero-median patches of spine combs.

TAXONOMIC DISCUSSION. Shelley *et al.* (1989) provided a full description of all life stages of *S. quadrivittatum* and discussed in detail all synonyms and misidentifications of this species. *Simulium quadrivittatum* shows little morphological variation in scutal pattern in populations from Belize, Ecuador, Puerto Rico and the Dominican Republic. Pupal filament variation was recorded in one specimen from Belize, with filaments being longer and more splayed out than in specimens from Ecuador. *Simulium quadrivittatum* is externally similar to *S. ganalesense* and S. *haematopotum* in the female and males. Irrespective of direction of light source *S. quadrivittatum* is unique in that the sub-median pruinose bands show a constriction at the posterior border of the cunae, which readily distinguishes it from *S. haematopotum* and similarly ornamented species of the *amazonicum* group. Both sexes of these species are easily distinguished on genitalia and pupae on gill configuration (see keys).

DISTRIBUTION. *Simulium quadrivittatum* was commonly found in highland areas in the Mountain Pine Ridge and to a lesser extent in lowland areas of Belize (Table 1, Material Examined, Maps 2, 15). In the Neotropical Region *S. quadrivittatum* has been recorded from Colombia, Costa Rica, Cuba, Ecuador, Guatemala, Jamaica, Mexico, Panama, Puerto Rico (Crosskey & Howard, 1996; Shelley *et al.* 1989) and the Dominican Republic (Material Examined), sometimes at high altitudes (Lewis & Garnham, 1960; Petersen *et al.*, 1983). The inclusion of Venezuela by Vargas (1945) in his distribution list of this species is presumably based on Ortiz (1944). However, Ramírez Pérez (1983) believes that a member of the *S. amazonicum* group (subgenus *Psaroniocompsa*) and not *S. quadrivittatum* was involved.

BIOLOGY AND MEDICAL IMPORTANCE. In Belize *S. quadrivittatum* was collected biting man sympatrically with *S. metallicum s.l.*. Pupae were less common, only being found in trickles to slow-flowing, 3 m wide streams, attached to submerged vegetation. Lewis & Garnham (1960), Petersen *et al.* (1983), Rubtsov & Garcia Avila (1972) and Shelley & Arzube (1985) recorded that *S. quadrivittatum* breeds in slow-flowing streams and shows population peaks in the wet season. In Ecuador it inhabits lowland, forested areas and plantations to the west of the Andean cordillera and only occurs in large numbers in the onchocerciasis focus in the north of the country (Shelley *et al.*,1989). *Simulium quadrivittatum* is highly anthropophilic in Ecuador (Shelley & Arzube. 1985), Central America (Fox, 1953; Lewis & Garnham, 1960; Petersen *et al.*,

1983) and in some Caribbean islands (Rubtsov & Garcia Avila, 1972), but it also bites equines (Vargas, 1945). It is a biting nuisance in tourist areas in Cuba and it has been recently reported from Las Tunas Province in the eastern part of the island (Mayda Castex, personal communication.). This species is only of medical importance in Ecuador where it is a vector of human onchocerciasis (Shelley, 1988a; Shelley & Arzube, 1985). In Panama it was a biting nuisance during the construction of a dam in Chiriqui Province (Petersen *et al.*, 1983), and has been shown to be a suitable experimental host to a Guatemalan strain of *O. volvulus* (Schiller *et al.*, 1984), although human onchocerciasis has not been recorded from Panama.

Simulium (*Psilopelmia*) *samboni* Jennings

(Figs. 6, 25, 37, 77, 78, 97, 110, 122, 134, 147, 184, 185, 206, 227, 247, 266, 267).

Simulium samboni Jennings, 1915: 199. HOLOTYPE ♀, PANAMA: Canal Zone, Empire, tributary of Comacho River, 4.x.1913 (*A.H.Jennings*) (USNM, cat. no. 19996). [Examined.]

Simulium colvini Dalmat, 1952:344. HOLOTYPE ♂ + pupal pelt, GUATEMALA: Department of San Marcos, stream between Malacatán and Ayutla, 18.vii.1951 (*J.Onofre Ochoa A., A.O.Lea, Jr. & H.T.Dalmat*) USNM, accession no. 13D-1). [Synonymy by Vargas & Díaz Nájera, 1954: 62.]

FEMALE. General body colour orange and green. Body length (specimens preserved in alcohol) 2.0–2.9 mm ($\bar{x}$=2.3 mm, s.d.=0.30, n=8), wing length 2.0–2.5 mm ($\bar{x}$=2.1 mm, s.d.=0.12, n=8), wing width 0.9–1.3 mm ($\bar{x}$=1.1 mm, s.d.=0.11, n=8).

Head – dichoptic with orange eyes; nudiocular area well developed (Fig. 25). Frons, clypeus and occiput black with silver pruinosity, frons and occiput with short, orange hairs on lateral margins and on basal margin of frons. Mouthparts and maxillary palps light brown. Antennae light brown. Cibarium with well developed and highly sclerotised cornuae, poorly sclerotised in central region; several irregular rows of varying size teeth from central trough to base of cornuae (Fig. 37).

Thorax – Scutum orange with numerous recumbent hairs, which appear black, brown or golden depending on light direction. Scutal pattern varying in appearance with illumination. With anterior illumination, 1+1 submedian, fine, silvery white, curved bands in form of lyre running from anterior to posterior margins and lateral margins beige with silver pruinosity; posterior margins orange (Fig. 77). With posterior illumination scutum orange with vestiges of lyre pattern in posterior fourth, lateral margins beige with silver pruinosity, posterior margins orange (Fig. 78). Paranotal folds beige with silver pruinosity. Pleura orange dorsally, brown ventrally with faint silver pruinosity. Scutellum orange with long, recumbent, brown bristles along anterior margin. Postnotum brownish with faint silver pruinosity. Costa of wing with dense distribution of spines and fine hairs. Subcosta with generally 8–10 setae (sometimes 3–5) in central portion, basal section of Radius with single row of setae; basal tuft of dark setae. Legs orange with brown bands as follows: distal two thirds of basitarsi and other tarsomeres in fore leg, coxae and basal two fifths of tarsomeres of mid leg, distal articulation of femora, distal half of tibiae, distal third of basitarsi and other tarsomeres (Fig. 97). Femora and tibiae of all legs with elongate scales. Claws of legs curved, without basal tooth. Halteres white with orange base.

Abdomen – tergites I–III greyish yellow, rest greyish green. Chequer board pattern on abdomen formed by rectangular velvet black areas as follows: tergites III–VI with central rectangle along length of segment, except in II where it occupies anterior half, tergites III–VII with 1+1 sub-median rectangles of different sizes, being larger on tergites III and IV and 1+1 lateral rectangles (Fig. 110). Occasionally the central rectangles are wider than those figured. Tergal plates well developed. Cerci dark brown, sternites and genitalia greyish green. Eighth sternite lightly sclerotised with even distribution of short setae with 2–5 larger setae on lateral margins; gonopophyses small membranous and setose (Fig. 122). Cerci hemispherical, paraprocts subrectangular, tapering antero-ventrally, rounded apically and with small protuberance anterior to cercus (Fig. 134). Genital fork with sclerotised stem, broad lateral arms and well developed anterior processes (Fig. 147). Spermatheca oval with no obvious external sculpturing and small groups of setae on internal surface; area of insertion of spermathecal duct membranous and about one fifth maximum width of spermatheca.

MALE. General body colour orange. Body length (specimens preserved in alcohol) 2.0–2.9 mm ($\bar{x}$=2.4 mm, s.d.=0.32, n=6), wing length 2.2–2.2 mm ($\bar{x}$=2.1 mm, s.d.=0.08, n=7), wing width 1.0–1.2 mm ($\bar{x}$=1.1 mm, s.d.=0.06, n=7).

Head – holoptic with eye facets dark red. Rest of head coloration as in female, except antennae dark brown.

Thorax – Scutum orange with recumbent, golden to dark brown hairs depending on light direction. Scutal pattern varies with light incidence: with anterior light source 1+1 silvery white pruinose triangles beginning on anterior scutal border and extending for one third length of abdomen (Fig. 184). With light source posterior to specimen pruinose marks absent (Fig. 185). Humeri and lateral margins of scutum greyish white with white pruinosity. Other areas of thorax as in female. Wing as in female except Subcostal vein bare

or with up to 3 setae in central portion. Leg coloration as in female (Fig. 97).

Abdomen – tergites I–III orange with brown mottling, rest velvet black, basal fringe with long, light brown hairs. Silver pruinose ornamentation as follows: tergite II faintly silver, tergites V, VI and VII with lateral margins silver. Genitalia and sternites greyish brown; sternal plates not developed. Gonocoxite square; gonostyle small – two thirds length of gonocoxite, conical, terminating in short, blunt spine (Fig. 206). Ventral plate lightly sclerotised with poorly developed basal arms and keel well developed with recumbent, long hairs (Fig. 227). Median sclerite oblong and well sclerotised (Fig. 227). Paramere with many spines of different sizes, many of which are well developed (Fig. 247).

PUPA. Cocoon length dorsally 2.4–2.9 mm ($\bar{x}$=2.6 mm, s.d.=0.18, n=15), ventrally 2.4–3.4 mm ($\bar{x}$=2.8 mm, s.d.=0.34, n=15), pupa length 2.4–3.5 mm ($\bar{x}$=2.8 mm, s.d.=0.39, n=15), gill length 3.0–4.2 mm ($\bar{x}$=3.5 mm, s.d.=0.36, n=16)

Cocoon light brown, slipper shaped (as in Fig. 6), composed of lightly woven threads and with reinforced anterior margin.

Gill light brown with eight forwardly directed branches. Main trunk of gill branching basally to a primary ventral branch, which further divides in basal fourth of gill to form two filaments. The dorsal primary branch then almost immediately divides to form two secondary branches. The dorsal secondary branch then bifurcates in the basal fourth of gill and the other branch in basal third of gill; then these tertiary branches bifurcate at the same level in basal half of gill (Fig. 266). This gill configuration was seen in several specimens, but branching heights are highly variable, especially in dorsal and median secondary branches (Fig. 267). Filaments fine, tapering slightly distally with spicules on surface, edges crenate and ends rounded; primary and secondary branches slightly wider.

Head with 2+2 frontal and 1+1 facial trichomes, well developed and bifid (sometimes trifid in frontal); surface of head generally with some scattered, rounded tubercles, but sometimes with no tubercles.

Thorax with 5+5 well developed simple to bifid trichomes dorsally and 2+2 simple trichomes ventrally; surface of thorax usually with scattered rounded tubercles over most of cephalothorax, but in some specimens largely devoid of trichomes, except for small groups of rounded tubercles in some areas.

Abdominal tergite I with 1+1 simple hairs laterally; tergite II with 4+4 simple setae in a longitudinal row on posterior margin of segment and 1+1 simple setae anterior to outermost of these; tergites III–IV with 4+4 simple spines on posterior border of segment and III with 1+1 simple setae anterior to most lateral of these and 1+1 simple setae on lateral border; tergite V with 1+1 sub-median setae on anterior margin, 2+2 simple sub-median setae on posterior margin and 1+1 setae on lateral margin; tergites VI, VII and VIII with row of backwardly directed spines on anterior margin and tergite VIII with 1+1 lateral groups of poorly developed spine combs; tergites VII–VIII with single row of backwardly directed stout spines on median anterior margin and 1+1 lateral groups of fine spine combs on anterior margins; tergite IX with 1+1 weakly developed, unbranched terminal spines and several rows of fine spine combs on anterior margin. Abdominal sternite III with median band of small spine combs in central area of segment, sternite IV with 1+1 simple or bifid spines on posterior margin, 1+1 small setae internal to these and band of spine combs on posterior margin; sternites V, VI and VII with 2+2 strong bifid spines, the outer being simple or bifid in VI and VII, 1+1 patches of spine combs anterior to spines in sternite V and anterior to inner spines in sternites VI and VII; sternite VIII with anterior half of segment covered by spine combs, sternite IX without spine combs.

TAXONOMIC DISCUSSION. Jennings (1915) gave short descriptions of the female and male of *S. samboni* and Dalmat (1952) provided a more complete description of the adults and pupa under the name *S. colvini*. Coscarón *et al.* (1996) described the adults, pupa and larva in their revision of the subgenus *Psilopelmia*. The species was named after Dr Louis Sambon who investigated the transmission of pellagra in the West Indies, at one time suspecting this vitamin deficiency to be associated with simuliid bites (Crosskey, 1990). Shelley *et al.* (1984) discussed the synonymy of *S. colvini* with *S. samboni* and synonymised *S. santaelenae* Ramírez Pérez & Peterson with *S. samboni*. Other authors regarded *S. santaelenae* and *S. sucamense* Nunes de Mello as conspecific and junior synonyms of *S. iracouboense* Floch & Abonnenc. In 1997 Shelley *et al.* accepted this latter action and described in detail the reasons for these synonymies under *S.* (*Psilopelmia*) *iracouboense*. We examined the holotype female and paratypes of both sexes and all were conspecific with our specimens from Brazil.

DISTRIBUTION AND BIOLOGY. *Simulium samboni* is a widely distributed species in Belize, commonly found in sympatry with *S. callidum* in rivers from Mountain Pine Ridge down to southern Belize (Table 1, Material examined, Maps 2, 16). Elsewhere *S. samboni* has been recorded in Colombia, Costa Rica, El Salvador, Honduras, Guatemala, México, Nicaragua, Panama, Trinidad and Venezuela (Coscarón, 1987; Crosskey & Howard, 1996); Material Examined).

In Mountain Pine Ridge *S. samboni* was collected in medium flowing (30 cm wide) to fast flowing (30 m wide) rivers, between 400 m to 700 m in altitude, with pupae and larvae attached to leaves, grasses or beds of

submerged vegetation. In southern Belize it was found between 40 m to 400 m in medium to fast flowing (up to 30 m wide) rivers, with pupae and larvae attached to fallen leaves and emergent vegetation.

BIOLOGY AND MEDICAL IMPORTANCE. In Belize *S. samboni* is zoophilic. Elsewhere in Latin America it is also zoophilic (Dalmat, 1955).

Simulium (*Simulium*) *metallicum* Bellardi complex

(Figs. 6, 26, 38, 79, 80, 81, 82, 83, 84, 85, 86, 98, 111, 123, 135, 148, 186, 187, 207, 228, 248, 268, 269).

This is one of the most common man-biting species in Central and northern South America and is medically important as a vector of human onchocerciasis.

Simulium metallicum Bellardi, 1859: 14. HOLOTYPE ♀, MEXICO, 1856 (*Sallé*). (MNHN [as Museo zoologico di Parigi]). [Examined.]

Simulium riveti Roubaud, 1906a: 108. HOLOTYPE ♀, ECUADOR: Napo Province, 1902 (*Dr G.Rivet*) (MNHN). [Synonymy with *S. metallicum* Bellardi by Wygodzinsky, 1971: 12.] [Examined.]

Simulium nitidum Malloch, 1912: 652. HOLOTYPE ♀, PERU: Huancabamba, 6.ix.1911 (*C.H.T. Townsend*) (USNM, cat.no. 15307). [Synonymy with *S. metallicum* by Shelley *et al.*, 1982: 28.] [Examined.]

Simulium versicolor Lutz & Nuñez Továr, in Lutz 1928: 47. SYNTYPES ♀♀, VENEZUELA: Caracas, Maracay, Turmero, El Limón, Ocumare de la Costa, 1925 (*Lutz, A. & Nuñez Továr*) (IOC). [Synonymy with *S. metallicum* by Ramírez Pérez, 1983: 2.]

Simulium avidum Hoffmann, 1930a: 51. SYNTYPES ♀♀, MEXICO: Chiapas, Soconusco District, Finca 'La Granja', ix.- x.1929 (*C.C.Hoffmann*) ([No depository cited], type number 18103). [Synonymy with *S. metallicum* by Dampf, 1931: 760.]

Simulium violacescens Enderlein, 1934: 285. HOLOTYPE ♀, Mexico, (*Deppe*) (ZMHU, cat no. 7074). [Synonymy with *S. metallicum* by Coscaron *et al.*, 1999: 568.These authors cite the original description date as 1933 as printed on journal, actually distributed in February 1934.]

FEMALE. General body colour black. Body length (specimens preserved in alcohol): man-biting 2.0–3.1 mm ($\bar{x}$=2.5 mm, s.d.=0.24, n=30) reared 2.0–2.4mm ($\bar{x}$=2.2 mm, s.d.=0.13, n=30), wing length: man-biting 1.6–2.0 mm ($\bar{x}$=1.8 mm, s.d.=0.09, n=29) reared 1.7–1.9 mm ($\bar{x}$=1.8 mm, s.d.=0.06, n=4), wing width: man-biting 0.8–0.9mm ($\bar{x}$=0.9, s.d.=0.07, n=30) reared 0.9–1.0 mm ($\bar{x}$=0.9, s.d.=0.02, n=4).

Head – dichoptic with red eyes; nudiocular area well developed (Fig. 26). Frons, clypeus and occiput black with silver pruinosity, frons and occiput with several, long black hairs on lateral margins and on basal margin of frons. Mouthparts and maxillary palps dark brown. Antennae brown with scape, pedicel and basal third of first flagellomere yellow. Cibarium with well developed and highly sclerotised cornuae, poorly sclerotised in central region and lacking teeth in central trough (Fig. 38).

Thorax – scutum black with numerous recumbent hairs, which appear black, brown or golden depending on light direction. Scutal pattern varying in appearance with illumination. With anterior illumination, thorax black with following areas silvery grey: 1+1 median vittae extending from anterior margin of scutum for three quarters length of scutum, vittae widening towards posterior of scutum; 1+1 drop-shaped, wide, sub-median vittae beginning in anterior third of scutum and extending posteriorly to terminate at same level as median vittae; 1+1 sub-median, highly iridescent, circular patches on anterior margin; silver humeri (Fig. 79). With posterior illumination scutal pattern reverses with black areas becoming silver pruinose and silver pruinose areas becoming black, humeri remain silver (Fig. 80). Variation in scutal pattern occurs but is slight with most specimens conforming to the pattern described. Vittae may be wider, as in one specimen median vittae join posteriorly (Figs. 81, 82) (also seen in specimens from Ecuador, Panama and Venezuela) and may be almost completely merged (Fig. 83, 84) (also seen in a specimen from the Caripe onchocerciasis focus in Venezuela and the South Chiapas onchocerciasis focus of Mexico). Scutellum dark brown with several black bristles. Pleura silver pruinose. Postnotum black with silver pruinosity. Costa of wing with relatively sparse distribution of spines and fine hairs. Subcosta with no setae, basal section of Radius without setae; basal tuft of dark hairs. Legs dark brown to black with lighter banding as follows: fore-leg coxae, trochanters and femora and external median surface of tibiae light brown, external face of tibiae appears white with some light incidences; mid legs with all tarsal segments cream with distal tips light brown; hind legs with basal two-thirds of basitarsi cream (Fig. 98). Femora and tibiae of all legs with elongate scales. Claws of legs curved, each with basal tooth, well developed on hind leg. Halteres lemon yellow.

Abdomen – tergites I–V velvet black with silver pruinosity on lateral face of tergite II and on postero-lateral margins of segments II–V (only seen in specimens with distended abdomens); tergites VI–IX shiny, brownish black (Fig. 111). Tergal plates well developed. Sternites and genitalia greyish black. Eighth sternite lightly sclerotised with even distribution of short setae except in central area, gonopophyses small membranous and setose with 2–5 larger setae on internal margins (Fig. 123). Sternite VII with no median sternal plate. Cerci hemispherical, paraprocts conical

with curved dorsal surface (Fig. 135). Genital fork thin and lightly sclerotised, terminations of lateral arms convoluted with poorly developed anterior processes (Fig. 148). Spermatheca oval with no obvious external sculpturing and small groups of setae on internal surface; area of insertion of spermathecal duct membranous and about quarter maximum width of spermatheca.

MALE. General body colour black. Body length (specimens preserved in alcohol) 2.5–3.0 mm ($\bar{x}$=2.7 mm, s.d.=0.18, n=7), wing length 1.7–1.9 mm ($\bar{x}$=1.8 mm, s.d.=0.07, n=6), wing width 0.7–1.0 mm ($\bar{x}$=0.9, s.d.=0.11, n=5).

Head – holoptic with eye facets dark red. Rest of head coloration as in female, except antennae dark brown.

Thorax – scutum velvet black with recumbent, dark brown hairs. Scutal pattern varies with light incidence: with anterior light source 1+1 silver pruinose triangles beginning on anterior scutal border and extending for half length of abdomen (Fig. 186). With light source posterior to specimen pruinose marks absent (Fig. 187). Humeri, lateral and posterior margins of scutum silver pruinose. Scutellum velvet black with long, dark brown setae; postnotum black with silver pruinosity. Wing as in female. Leg coloration as in female except hind legs with basal half of basitarsi cream (Fig. 98).

Abdomen – tergites velvet black, basal fringe with long black hairs. Silver pruinose ornamentation as follows: tergite II completely silver, tergites V, VI and VII with most of lateral margins silver. Genitalia black, sternites black; sternal plates poorly developed. Gonocoxite broadly rectangular; gonostyle conical, elongate terminating in single large spine (Fig. 207). Ventral plate well sclerotised with well developed basal arms and keel well developed with recumbent, long hairs (Fig. 228). Median sclerite pyriform about twice as long as width at widest part (Fig. 228). Paramere with few (up to six) well developed spines (Fig. 248).

PUPA. Cocoon length dorsally 2.7–3.5 mm ($\bar{x}$=3.1 mm, s.d.=0.32, n=11), ventrally 3.0–3.7 mm ($\bar{x}$=3.3 mm, s.d.=0.26, n=13), pupa length 3.0–3.5 mm ($\bar{x}$=3.4 mm, s.d.=0.19, n=13), gill length 3.9–5.2 mm ($\bar{x}$=4.5 mm, s.d.=0.47, n=13).

Cocoon light brown, slipper-shaped (as in Fig. 6), composed of lightly woven threads and with reinforced anterior margin. Gill light brown with six forwardly directed branches.

Gill filament branching very basal and configuration variable, sometimes with one gill differing from other in same pupa. Variations in configuration are as follows: more commonly main trunk giving rise to a dorsal and two ventral primary branches (both on same horizontal plane), dorsal arising more basally than the inner and outer ventral branches. Each primary branch gives rise almost immediately to two filaments with bifurcation in dorsal primary branch being more basal than two ventral primary branch bifurcations, which are at same level (Fig. 268). A variation occurs where main trunk gives rise to a dorsal and ventral primary branches, the dorsal then dividing again to form a ventral and dorsal secondary branch each of which gives rises to two filaments – collectively the two secondary and ventral primary branches are in the vertical plane (Fig. 269). Filaments fine, slightly tapering distally with spicules on surface, edges crenate and ends rounded; primary and secondary branches slightly wider.

Head with 2+2 frontal and 1+1 facial trichomes well developed and bifid (frontal sometimes trifid); surface of head covered with rounded tubercles, which are large on frontal region and smaller on sclerites covering eyes.

Thorax with 5+5 well developed bifid to quadrifid trichomes; surface of thorax covered with rounded tubercles, larger in anterior half.

Abdominal tergite I with 1+1 simple hairs laterally; tergite II with 3+3 sub-median simple setae and 3 simple setae in a longitudinal row on lateral margin; tergites III–IV with 4+4 simple spines and III with 1+1 sub-median simple setae on anterior border; tergites V–VI with poorly developed spine combs on anterior margin, more obviously laterally; tergites VII–VIII with single row of backwardly directed stout spines on median anterior margin and 1+1 lateral groups of fine spine combs on anterior margins; tergite IX with 1+1 strong, unbranched terminal spines and several rows of fine spine combs on anterior margin. Abdominal sternite III with median band of small spine combs in central area of segment, sternite IV with 4+4 sub-median simple (sometimes bifid) spines of which the second most median is better developed, spine combs covering anterior two thirds of segment; sternite V with 2+2 strong spines, outer simple or bifid and inner with 4 branches with 1+1 patches of spine combs anterior to them, 1+1 lateral simple hairs in central part of segment; sternites VI–VII with 2+2 well developed bifid spines (sometimes outer ones simple) and 1+1 patches of spine combs anterior to them; sternite VIII with 1+1 patches of sub-median spine combs on anterior border.

TAXONOMIC DISCUSSION. This species was first described in 1859 by Bellardi from a 'male' deposited in the MNHN, Paris and collected by the French entomologist Sallé in Mexico. The limited description refers to the specimen's colour as blue black metallic. No indication of the number of specimens was given. Later, Roubaud (1906b) was unable to find a male but located a female of *S. metallicum* collected by Sallé in Mexico in 1856. This female was either the only specimen left from Sallé's collection or Sallé only

collected one specimen. We believe that Bellardi incorrectly cited the sex of this species because his description of the male as blue black metallic better describes a female than the male, which is largely velvet black. This is perplexing because Bellardi described both the male and female of *S. cinereum* (= *S. virgatum s.s.*) in the same paper, but in the case of *S. metallicum* not the female, which Sallé had collected. A similar confusion over gender is thought to have occurred with *S. mexicanum* Bellardi deposited in the Turin Museum (Shelley *et al.*, 1989). Roubaud's description of the female (1906b) is more detailed and it is on this that the modern concept of the species is based. We have examined this specimen (Figs 85, 86), which is lacking the head, a wing, a fore and hind leg, has a light fungal growth and is pinned through the scutum. Nevertheless, sufficient features of the scutal pattern and leg coloration are present to conclude that the specimen is *S. metallicum*. Therefore, we now accept the only extant specimen (female) from Sallé's collection as the holotype and have labelled it as such. Various authors then provided descriptions of the different life stages of *S. metallicum*. Fairchild (1940) pointed out an error made by Malloch (1914) and repeated by Pinto (1932) in associating a pupa with eight filaments with *S. metallicum*, which has six filaments. The most comprehensive description of the species is by Dalmat (1955) and Okazawa & Onishi (1980), while Coscarón *et al.* (1999) review the species in relation to other members of the subgenus *Simulium* and list sources of morphological descriptions.

Various species have been described, which have since fallen in synonymy with *S. metallicum*. Roubaud (1906a) described *S. riveti* based on eight female specimens collected by Dr G. Rivet from Napo Province in Ecuador. The species was subsequently referred to by various authors cited in Wygodzinsky (1953), who gave a more detailed description of the man-biting female (the only stage known at the time) that he had collected in Ecuador. Later, Wygodzinsky (1971) collected conspecific adults, larvae and pupae of which the females corresponded to his interpretation of *S.riveti*, and based on this new material synonymised S.*riveti* with *S. metallicum*. Six specimens of *S.riveti* were located in the MNHN of which one was labelled as type, and a further specimen in the BMNH. All bear printed labels indicating collector, date and locality and the type specimen also has a label in Roubaud's hand with the species name and 'Type'. We have added a holotype label to this specimen and paratype labels to the six other specimens. All are of the same species and are in relatively good condition. Scutal patterns are not clear because the specimens have been recovered from alcohol and are crinkled, but appear close to that seen in *S. metallicum*. One of the paratypes from the MNHN has been dissected and morphologically corresponds with the figures of *S riveti* (Wygodzinsky, 1953) as well as with specimens of *S. metallicum* in the BMNH, so confirming the synonymy of *S.riveti*. In 1912 Malloch described the new species *S. nitidum* from Peru based on two females collected at Huancabamba. Lutz (1917) synonymised *S. nitidum* with *S. amazonicum* on examination of material from the same locality and comparison with Malloch's description (1912). The name was later synonymised with *S. metallicum* by Shelley *et al.* (1982) during their revision of *S.amazonicum*, following an examination of the holotype female of *S. nitidum*. The name *S. avidum* was given to two females collected and described by Hoffmann (1930a) from Chiapas State in Mexico. Later, during investigations into potential vectors of human onchocerciasis in Chiapas and Oaxaca states Dampf (1931) considered *S. avidum* to be conspecific with *S. metallicum*. This synonymy was cited by Bequaert (1934) and attributed to Dampf in his revision of Simuliidae from a zone of onchocerciasis in Guatemala. In Smart's catalogue of World Simuliidae (1945) the synonymy is incorrectly attributed to Bequaert (1934). A visit, facilitated by the President of Venezuela, was made to the north of this country in 1925 by the Brazilian simuliid specialist Lutz in the company of the Venezuelan entomologist Nuñez Továr to study the animals of the area, including blood sucking insects. A new species of simuliid, *S. versicolor*, was described from females and pupae. Later, Ramírez Pérez (1983) collected specimens from the same area and concluded that *S. versicolor* was a synonym of *S. metallicum*. From the description and figures of the female in Lutz (1928) we support the above synonymy. The type series was almost certainly deposited in IOC together with other species described in the same paper, but these specimens have been lost (Dr M. Maia-Herzog, personal communication). As Lutz points out there was a delay in producing this work because of the artwork and translation from Portuguese to Spanish and because of the ill health of the second author. Hence, there are various errors in references to the figures, some of which have been corrected by D'Andretta & D'Andretta (1946). Thus, on p.47 Fig. 2 of Plate 4 of the female should read Fig. 1; this is correctly cited by Lutz as Fig. 1 in the figure legends on p. 131. According to d'Andretta & d'Andretta (1946) on p. 47 plate 6 Fig. 3 should read Fig. 7 and on p.131 Fig. 4 *S. versicolor* should read *S. incrustatum* and Fig 7 *S. subnigrum* should read *S. versicolor*. Comparison of pupal gills of *S. metallicum* in the BMNH collection (see Material Examined) corresponds most closely with Fig. 4 as Lutz (1928) correctly cites on p.131 and Fig. 3 on p.47 should be amended to Fig. 4. Coscarón *et al.* (1999) synonymised *S. violacescens* with *S. metallicum* after examining type material of the former species.

Several species are closely related to *S. metallicum*, but have been described on differences in adult and

pupal morphology. *Simulium jobbinsi* and *S. puigi* were described as new species by Vargas *et al.* (1946) and *S. racenisi* and *S. horacioi* were described some years later as species related to *S. metallicum*. We examined type material of all these species except *S. puigi*. Based on descriptions and figures by these authors differences in genital fork and ventral plate morphology separate *S. jobbinsi* from *S. pnigi*. We examined male and female *S. jobbinsi* in the BMNH collection [identified by Dalmat] as well as the male holotype, a female paratype and pupae, a sympatric species very similar to *S. metallicum*, of which the male, female and pupa were first described from the onchocerciasis focus at Socunusco in Chiapas State in Mexico by Vargas *et al.* (1946). Later, Dalmat (1955) fully redescribed the species from Guatemala as did Vargas & Díaz Nájera (1957) in their revision of Mexican Simuliidae. We confirm the following morphological differences described by these authors [(a) = observations by Vargas & Díaz Nájera (1957) and (b) by Dalmat (1955)]. In the female, the Radius has spines and hairs in distal half in *S. jobbinsi* and only spines in *S. metallicum* (b), difference in length of the stem of the genital fork in relation to the length of the lateral arms (a, b) and there is a basal knob in *S. jobbinsi* but none in *S. metallicum* (b) and the lateral arms are morphologically different (Figs. 148, 149); in *S. jobbinsi* the paraproct is longer and slightly more pointed apically than in *S. metallicum* (a,b). In the male the ventral plate of *S. jobbinsi* is without shoulders while *S. metallicum* has shoulders (a, b) (Figs. 228, 229), the base of the gonostyle of *S. jobbinsi* and *S. metallicum* differs in shape (Figs. 207, 208). We were unable to confirm the following differences in females: differences in width of mesonotal vittae between the two species (a) – we found this to vary intraspecifically in *S. metallicum*, the periphery of the mesonotum in *S. jobbinsi* is white pruinose while in *S. metallicum* it is not continuous on the anterior margin (b) – not seen in limited number of BMNH specimens of *S. jobbinsi* and a female from Chiapas State, Mexico. In males the mesonotum has yellow-gold, scale-like hairs in *S. jobbinsi* that are absent in *S. metallicum* (b) – no scale-like hairs were noted in the few BMNH specimens. The presence of striations [=hairs] on the ventral plate of *S. jobbinsi* and their absence in *S. metallicum* (a) – hairs were seen in both species in our material, but *S. jobbinsi* was more hirsute; the gonostyle of *S. jobbinsi* is rounded apically without a spine – the gonostyle in the *S. jobbinsi* holotype is rounded apically but has a sub-terminal fine spine, whereas *S. metallicum* has a distally pointed gonostyle with a distal spine (a,b) (Figs. 207, 208). Other differences between the two species have been reported for pupae in gill configuration (a) and in the cocoon without 'lateral wings' and without spines or spine combs on tergite VI (b) of *S. jobbinsi*. We were unable to note differences in pupal gill configuration (Figs. 268, 270), which falls within the variation in *S. metallicum s.l.* Also the lateral extension of the cocoon and tubular form of the cocoon were seen in the specimens of both *S. jobbinsi* and *S. metallicum* . However, the gills of *S. jobbinsi* are longer (6.3–7.6 mm) than those of *metallicum.* (3.9–5.2 mm) and the absence of spines on tergite VI in *S. jobbinsi* is confirmed. We confirm that *S. jobbinsi* is distinct from *S. metallicum s.l.*.

Simulium racenisi was described by Ramírez Pérez in 1971 from material that he had collected in Miranda State in the R. Caurimare as a result of an observation in the graduate thesis of Tallaferro that specimens from this locality were similar to *S. metallicum,* but probably a distinct species. A pinned paratype female was deposited in the BMNH and after examining *Simulium* sp. G in the BMNH of Lewis (1963) and Lewis and Ibáñez Aldecoa (1962) collected in the nearby northern coastal area near San Antonio de Maturin in the Caripe part of the onchocerciasis focus Ramírez Pérez considered them to be conspecific. Lewis (1963) considered female *Simulium* sp. G as different from *S. metallicum* based on paler scales on the mesonotum, the pale area of the front femur being more central and ventral in *Simulium* sp. G and in the pupae of *Simulium* sp. G the upper filament of branch 1 (dorsal primary branch) being straight and not curved. He also figured the male gonocoxite and gonostyle and ventral plate and paramere but made no observations. Ramírez Pérez (1971) distinguished *S. racenisi* from *S. metallicum* through figures of differences in the female paraproct and genital fork and male ventral plate and gonostyle and more distal branching of the filaments in pupae of *S. racenisi*. We have examined the female paratype of *S. racenisi* in the BMNH, various specimens of *Simulium* sp. G of Lewis and *S. metallicum* collected by Lewis in various localities (Material Examined) in the onchocerciasis region of northern Venezuela. We agree with Ramírez Pérez that *S. racenisi* and *Simulium* sp. G are conspecific and have the following observations to make. In the female the white pale area of the front femur varies in both *S. metallicum* and *S. racenisi* and cannot be used as an interspecific character; the scutal tomentum of both species is composed of setae that appear golden to dark brown depending on light direction; the paraprocts are of a different shape and more rounded posteriorly in *S. racenisi* compared to *S. metallicum* and the paraproct in *S. racenisi* extends beyond the cercus by half the length of the cercus whereas in *S. metallicum* it is almost by a full length (Figs. 135, 136); the ends of the lateral arms of the genital forks of the two species are slightly different.. In the male of *S. racenisi* the gonostyle (Fig. 209) is distended distally and bears a sub-terminal spine (spine not shown in figure of Ramírez Pérez, 1971) and not like *S. metallicum*, which is tapered apically with a terminal spine (Fig. 207); the ventral plate (Fig. 230)

has a poorly developed keel in *S. racenisi* compared to *S. metallicum* (Fig. 228). In pupae tergite VI has an irregular row of backwardly directed spines on the anterior border in *S. metallicum* and not in *S. racenisi*; the base of the primary dorsal branch of the gill of *S. racenisi* (Fig. 271) is straight but curved in *S. metallicum* (Fig. 268) and branches slightly more distally than in *S. metallicum*. The paucity of *S. racenisi* specimens did not allow us to discover whether these are distinguishing characters or a character variation in that particular population.

Simulium horacioi was fully described from Guatemala by Okazawa & Onishi (1980) as a species closely related to *S. metallicum* originally observed by Onishi *et al.* (1977) based on morphological characters in larvae and pupae, but Takaoka in Tada (1983) suggested the possibility of *S. horacioi* being a junior synonym of *S. racenisi* Ramírez Pérez. Two characters in the females of the two species (Okazawa & Onishi, 1980) that require further investigation are that in *S. metallicum* the paraproct extends beyond the cercus and the seventh sternite is unsclerotised, whereas in *S. horacioi* the paraproct is not extended and a small sclerotised sternal plate is present. In most of the specimens examined in the BMNH collection (See Material Examined) the combination of these two characters in *S. metallicum* is seen. However, in three man-biting females from Morelos in Chiapas State of Mexico, the seventh sternite has a sclerotised plate as in *S. horacioi* while the paraprocts extend beyond the cercus as in *S. metallicum*. Table 4 summarises a comparison that we have made between *S. metallicum* and the three closely related species *S. jobbinsi, S. horacioi* and *S. racenisi* using type specimens. The three latter species are similar in adult coloration and some morphological differences are apparent in adult genitalia and pupal chaetotaxy, but we are not making any synonymies – these should be made if necessary in conjunction with DNA and cytological analyses of populations showing these morphological variations. Unfortunately, the dissected paratypes of *S. horacioi* listed in Okazawa & Onishi (1980) as being deposited in the 'Laboratorio de Investigaciónes Científicas Dr Isao Tada', Servicio Nacional de Erradicación de la Malaria in Guatemala City, Guatemala have been lost (Dr Jaime Abraham Juárez, personal communication). The type material listed in Material Examined in the NSMT is preserved in alcohol and we figure the pupal gill (Fig. 272).

Shelley (1988a) commented that the use of certain morphological characters as species specific by Okazawa & Onishi (1980), which in other Neotropical species vary intraspecifically, could mean that *S. horacioi* may be a species within the newly discovered *S. metallicum* complex. *Simulium metallicum* was first shown to be a complex of two cytotypes A and B in Guatemala while A occurs in Venezuela (Hirai & Uemoto, 1984; Hirai in Tada, 1983, 1985, 1987). Later, Conn *et al.* (1989) and Conn (1990) described and keyed 11 sibling species denominated A-K from Central and northern South America. Further siblings have been reported as X from Mexico by Millest (1989, 1990) and L from Colombia by Arteaga & Muñoz de Hoyos (1996, 1999). Of these ABEHIJ and K are regarded as good species and CDFGLX as cytotypes until further information is available to decide their specific status. Cytospecies A is regarded as *S. metallicum sensu stricto* and cytospecies H may be *S. horacioi*. Arteaga, & Muñoz de Hoyos (1999) revised the chromosomal key to *S. metallicum* cytotypes to include their cytotype L but omitted cytotype X of Millest (1989,1990). Millest (1990) reported an attempt to associate larval head spot pattern and body coloration with cytotype in Mexico as successful in most cases, though cytotypes B and X were indistinguishable morphologically and some morphological overlap occurred in some specimens of different cytotypes. This author also argued that morphological variation may exist within the same cytotypes in different populations in Guatemala and Mexico and recommended more detailed integrated taxonomic studies. Furthermore, Millest (1990), using mainly penultimate but some last instar larvae, maintained that little variation in head pattern occurred between the two stages. Later work on the human onchocerciasis vector species complex *S. exiguum* in Ecuador (Charalambous *et al.*, 1997) showed that larval head patterns cannot be reliably used to distinguish two members of this complex from the sympatric, zoophilic species *S. gonzalezi*, nor to distinguish two of the complex's cytotypes, because head pattern varies from positive to negative within cytotype in *S. exiguum* and also this character may be sex linked. In 1999 Millest *et al.* cited cytotype H as *S. horacioi* and this has been followed in Crosskey (2002). Following an examination of Millest's data (1990), which shows an overlap in body colour and head pattern in cytotypes H, I, and X, we prefer to maintain *S. horacioi* as a member of the *S. metallicum* complex with the possibility that it is cytotype H, until *S. horacioi* has been collected from its type locality and a chromosomal analysis made of its larvae to establish its true identity. Two populations of *S. metallicum* were distinguished using morphology and enzymes by Petersen (1982), but their relationship with the four cytotaxa recorded for Panama is not known and Agatsuma *et al* (1986) used blackfly isozymes, which showed *S. horacioi* to be less closely related to an undetermined cytotype of *S. metallicum* than anticipated. The use of mitochondrial DNA for distinguishing cytotypes and for assessing phylogenetic relationships has been shown to be viable in the *S. metallicum* and *S. ochraceum* species complexes (Agatsuma *et al.*, 1993 and Tang *et al.*, 1996). A taxonomic revision integrating morphology, cytology,

enzymes and DNA is long overdue for *S. metallicum* and closely related species.

DISTRIBUTION. *Simulium metallicum s.l.* occurs at various localities in Belize at altitudes above 50 m, especially in the higher Mountain Pine Ridge (Table 1, Material Examined, Maps 2, 17). *Simulium metallicum* has been recorded from the following countries (cytotaxa where known in brackets) Belize, Brazil, Colombia (CL), Costa Rica (G), El Salvador, French Guiana, Guatemala (ABHI), Ecuador, Honduras, Jamaica, Mexico (ABHIX), Nicaragua, Panama (FHJK), Peru, Trinidad, Venezuela (DE) (Arteaga & Muñoz de Hoyos, 1996; Crosskey, 2002; Crosskey & Howard, 1996; Hamada & Grillet, 2001; Muñoz de Hoyos, 1994; Material Examined).

BIOLOGY AND MEDICAL IMPORTANCE. In Belize *S. metallicum s.l.* is commonly found biting man voraciously in Mountain Pine Ridge, sympatrically with *S. quadrivittatum* between 400–700 m in altitude (Material Examined, Map 2). Pupae and larvae were collected in small, sometimes shaded, slow to fast running streams varying from 1m wide and 10 cm deep to 10 m wide and 50 cm deep always attached to fallen leaves, grasses and beds of submerged vegetation.

There have been numerous publications concerning the biology and medical importance of *S. metallicum s.l.* in Latin America. The following give reviews and/or access to the literature: Ramírez Pérez, (1971, 1977), Shelley (1988a, 1988b, 1991). *Simulium metallicum s.l.* typically breeds in small shaded streams but can occur in larger rivers, bites man voraciously even in areas where it is largely zoophilic, but where population numbers are high. In Guatemala Dalmat (1955) recorded this species biting the following animals: horses, mules, donkeys, cattle, sheep, goats, deer, pigs, dogs, foxes, cats, ocelots, tayras (weasels), chickens, turkeys, ducks. Little information is available on the biology of the cytotypes of the *S. metallicum* complex. Grillet & Barrera (1997) and Grillet *et al.* (1995) studied the biology of *S. metallicum* cytotype E larvae in an area of northern Venezuela where onchocerciasis occurs and where this cytotype is probably a vector of the disease (Takaoka *et al.*, 1984). Distribution was recorded in relation to physical and chemical characteristics of streams and highest populations were recorded at the end of the wet season. Takaoka (1982) studied the bionomics of *S. horacioi* in relation to *S. metallicum s.l.;* although the latter species was found naturally infected with *O.volvulus* L3 larvae none was found in *S. horacioi*, though sample size was small. Takaoka (in Tada, 1983) collected no *S. raceuisi* biting man or animals in northern Venezuela. Lewis (1963) and Ramírez Pérez, (1971, 1977) made no mention of this species biting man.

Simulium metallicum s.l. is a primary vector of human onchocerciasis in northern Venezuela, but only a secondary vector in the Central American foci because of its largely zoophilic habits. Its lack of cibarial teeth in the female facilitates it role as an effective host to *O. volvulus* in areas where it is anthropophilic. *Simulium metallicum s.l.* is a poor host to the virus causing Venezuelan Equine Encephalitis in Colombia and if involved in cyclical or mechanical transmission of the virus is not considered as an important vector (Homan *et al.*, 1985). In Ecuador León & Wygodzinsky (1953) cited *S. metallicum s.l.* (as *S. riveti*) and *S. exiguum s.l.* as vectors of 'mal del pinto' or 'carate' (a skin condition, now uncommon, also referred to as 'pinta' and caused by a spirochaete *Treponema carateum* (similar to *T. pallidum*, which causes syphilis) based on the presence of these species where the condition occurs).

CONCLUSIONS

The present survey of Belize covered the whole country, which was not possible in the previous survey of Lewis & Garnham (1960) because of the difficulty of access to parts of the Maya Mountains and southern lowlands. The nine identified species originally recorded for the country have now increased to twelve.

No simuliids were obtained from most of the area of the country lying to the north of the Belize City-Belmopan highway because this is a flat region below 50 m altitude (Map 2) where any water courses found contained stagnant water. This is an area of limestone and sand (Map 3), low rainfall (Map 4) and coastal mangrove swamps, dry savannas and highly disturbed pockets of forest (Map 5). Simuliids were found breeding in the wetter southern half of the country (Map 4), especially in the higher regions of the Maya Mountains (Maps 2, 4). Species of the subgenus *Hemicnetha* (Maps 6, 7, 8, 9,) that are typically found in fast flowing rivers and waterfalls were largely confined to the mountainous granitic and Palaeozoic sediment areas of the Mountain Pine Ridge (Map 3), which is largely composed of savannas and pine forests bordered by semi deciduous forests (Map 5). A similar distribution pattern was recorded for *S. callidum, S. metallicum s.l., S. ochraceum s.l.* and *S. quadrivittatum* (Maps 12, 14, 15, 17). *Simulium ganalesense* (Map 11) was confined to the coastal lowlands (Map 2) in areas of alluvium and sand (Map 3) and savannas and small stands of pine and pockets of highly disturbed tropical forest (Map 5). The other three species recorded (*S. gonzalezi, S. haematopotum* and *S. samboni* (Maps 10, 13, 16)) were found throughout the country.

Six of the species collected (*S. callidum, S. gonzalezi, S. haematopotum, S.metallicum s.l., S. ochraceum s.l.* and *S. quadrivittatum*) are known to bite man in other parts of Latin America and an additional species, *S. ganalesense*, was highly anthropophilic in the country.

In Belize *S. callidum* was commonly collected, but never biting man. In Guatemala and Mexico it is also mainly zoophilic, but will bite man when large populations occur as will *S. haematopotum*. *Simulium ochraceum s.l.* was very uncommon in Belize and hence its feeding behaviour there is not known. Similarly, *S. gonzalezi* was uncommon, but was found biting man. The two most important man-biting species in Belize were *S. metallicum s.l.* and *S. ganalesense*, both of which attacked in large numbers in some localities.

The following species collected in Belize are known to be vectors of *Onchocerca volvulus* in other parts of Latin America (Shelley, 1988a): *S. ochraceum s.l.* and *S. metallicum s.l.* are primary vectors in Central America and Venezuela respectively, and *S. callidum, S. gonzalezi, S. haematopotum* and *S. quadrivittatum* are secondary vectors. The parameters that affect vectorial competence of simuliid species in Latin America have been discussed by Shelley (1991). Assuming that large numbers of flies are biting man, the two most important factors that affect the capacity of a species to host the parasite are the degree of zoophily and the morphology of the female cibarium. If a species that bites man in large numbers is mainly zoophilic most of the ingested filariae will be lost when an infective female feeds on an animal in preference to man. The other factor is the presence or absence of teeth on the cibarium. Species with cibarial teeth are poor hosts to the parasite because of the damage caused to microfilariae as they pass over these teeth in the ingested blood on their passage to the fly's stomach. The contrary is usually true for species with unarmed cibariums. In Belize the only species that could be potential hosts to *O. volvulus* because of high biting populations are *S. metallicum s.l.* and *S. ganalesense*. Of these *S. metallicum s.l.*, if largely anthropophilic, would be a more likely host because of its unarmed cibarium than *S. ganalesense* with an armed cibarium. Therefore, the most likely area for future transmission of *O. volvulus* would be in and around Mountain Pine Ridge where *S. metallicum s.l.* mainly occurs (Map 17) than in the coastal lowland areas of banana and citrus plantations where *S. ganalesense* is commonly found (Map 11). Guatemalan immigrants currently pass into both areas and a major deciding factor on future onchocerciasis transmission in Belize will be the number of individuals arriving already infected with the disease. Onchocerciasis is being intensively treated by the administration of ivermectin to people living in the disease foci in Guatemala and the Onchocerciasis Elimination Programme for the Americas estimates that over 80 % of people receive treatment (Dadzie *et al.*, 2002). The problem lies in the numbers of people refusing treatment, exempt from treatment, or not undergoing regular six monthly treatment that may be migrating to Belize. Although the Belizean authorities may be able to monitor legal immigrants to the country for *O. volvulus* the main threat comes from the illegal immigrants who enter the country for economic reasons in ever increasing numbers. Therefore, it is not possible to estimate at this stage whether a serious threat of onchocerciasis introduction to Belize occurs.

REFERENCES

Agatsuma, T., Hirai, H., Ochoa, J.O. & Tada, I. 1993. Typing of *Simulium* using mitochondrial DNA PCR products with restriction endonuclease digestion. *Annals of Tropical Medicine and Parasitology*, **87**: 307–309.

Agatsuma, T., Uemoto, K. & Onofre Ochoa, A., J. 1986. Biochemical genetics of blackfly isozymes. I. Isozyme variation among three species, *Simulium ochraceum*, *S. metallicum s.l.* and *S. horacioi* from Guatemala. *Japanese Journal of Sanitary Zoology*, **1**: 1–9.

Arteaga, L.T. & Muñoz de Hoyos, P. 1996. Estudio citológico de *Simulium* (*Simulium*) *metallicum* presente en el Transecto Bogota-Honda (Diptera:Simuliidae). *Resúmenes XXIII Congreso Sociedad Colombiana de Entomología*, **1996**: 29.

Arteaga, L.T. & Muñoz de Hoyos, P. 1999. New cytotype in the *Simulium metallicum* complex (Diptera:Simuliidae) from Cundinamarca, Colombia. *Journal of Medical Entomology*, **36**: 133–140.

Bateson, J.H. & Hall, I.H.S. 1977. The geology of the Maya Mountains, Belize. *Institute of Geological Sciences Overseas Memoirs*, **3**: 1–44.

Bellardi, L. 1859. Saggio di Ditterologia Messicana. Parte 1. *Memorie della Reale Accademia delle Scienze di Torino*, **19**: 13–14.

Bellardi, L. 1862. *Saggio di ditterologia messicana. Appendice*. 28 pp. Torini. [This is a separately issued and paginated appendix to Bellardi's Part I (1861) and Part II (1862) of *Saggio di ditterologia messicana*. It predates its subsequent issue in a journal].

Bequaert, J.C. 1934. Part III. Notes on the black flies or Simuliidae with special reference to those of the *Onchocerca* region of Guatemala. Pp. 175–224. *In* Onchocerciasis with special reference to the Central American form of the disease. *Contributions from the Department of Tropical Medicine and the Institute for Tropical Biology and Medicine*, **6**: i–xiv, 1–234.

Bradt, S. 1932. Notes on Puerto Rican black flies. *Puerto Rico Journal of Public Health and Tropical Medicine*, **8**: 69–81.

Briceño Iragorry, L. & Ortiz, I. 1957. Los simúlidos de Venezuela. (Importancia médica. Morfología y sistemática. Distribución geográfica.). *Boletin Venezolano de Laboratorio Clínico*, **2**: 23–57.

Brokaw, N. 1998. A history of plant ecology in Belize. *Journal of Belizean Affairs*, **3**: 1–40.

Charalambous, M., Lowry, C.A., Lowell, S., Shelley, A.J. & Arzube, M. 1997. The value of the larval head pattern for differentiating *Simulium exiguum s.l.* and *S. gonzalezi* (Diptera:Simuliidae) in the onchocerciasis focus of Ecuador. *Bulletin of Entomological Research*, **87**: 19–24.

Conn, J. 1990. Chromosome key to the larvae of the *Simulium metallicum* complex (Diptera:Simuliidae) from Latin America. *Journal of Medical Entomology*, **27**: 459–466.

Conn, J., Rothfels, K.H., Procunier, W.S. & Hirai, H. 1989. The *Simulium metallicum* species complex (Diptera:Simuliidae) in Latin America: a cytological study. *Canadian Journal of Zoology*, **67**: 1217–1245.

Coquillett, D.W. 1902. New Diptera from North America. *Proceedings of the United States National Museum*, **25**: 83–126.

Coscáron, S. 1987. El género *Simulium* Latreille en la Región Neotropical: Análisis de los grupos supraspecíficos, especies que los integran y distribución geográfica (Simuliidae, Diptera). *Museu Paraense Emílio Goeldi, Belém*, 112 pp.

Coscáron, S. 1985. Revisión del subgénero *Simulium* (*Ectemnaspis*)

Enderlein (Simuliidae, Diptera, Insecta). *Revista de la Sociedad Entomológica Argentina*, **43**: 283–325.

Coscáron, S. 1991. Taxonomía y distribución del subgénero *Simulium* (*Ectemnaspis*) Enderlein (Simuliidae, Diptera, Insecta). *Iheringia, série zoología*, **70**: 109–170.

Coscarón, S. & Ibáñez Bernal, S. 1995. Sobre la ubicación taxonómica de *Simulium ganalesense* Vargas, Martínez Palacios & Díaz Nájera (Diptera:Simuliidae). *Folia Entomológica Mexicana*, **90**: 1–7. [Publication date 1995 not 1994 as cited on reprint – see Crosskey & Howard, 1996, p. 88.].

Coscarón, S., Ibáñez Bernal, S. & Coscarón-Arias, C.L. 1996. Revisión de *Simulium* (*Psilapelnia*) Enderlein en la región neotropical y análisis cladístico de sus especies (Diptera:Simuliidae). *Acta Zaalógica Mexicana*, **69**: 37–104.

Coscarón, S., Ibáñez Bernal, S. & Coscarón-Arias, C.L. 1999. Revision of *Simulium* (*Simulium*) in the Neotropical realm (Insecta:Diptera:Simuliidae). *Memoirs on Entomology International*, **14**: 543–604.

Coscarón, S., Py-Daniel, V. & Coscarón-Arias, C.L. 1993. El subgénero *Simulium* (*Psilopelmia*) Enderlein en Sudamérica (Simuliidae, Diptera, Insecta). *Boletim do Museu Paraense Emílio Goeldi série Zoología*, **9**: 283–311.

Crosskey, R.W. 1988. An annotated checklist of the world blackflies (Diptera:Simuliidae). Pp. 425–520. *In* Kim, K.C. & Merritt, R.W., eds., *Blackflies: Ecology, population management, and an annotated world list*. The Pennsylvania State University, University Park.

Crosskey, R.W. 1990. *The natural history of blackflies*. ix + 711pp. John Wiley, Chichester.

Crosskey, R.W. 1999. *First update to the taxonomic and geographical inventary of world blackflies* (*Diptera:Simuliidae*). The Natural History Museum, London, 10 pp.

Crosskey, R.W. 2002. *Secand update to the Taxonomic and Geographical Inventory of Warld Blackflies* (*Diptera:Simuliidae*). The Natural History Museum, London, 14 pp.

Crosskey, R.W. & Howard, T.M. 1996. *A new taxonomic and geographical inventory of world blackflies* (*Diptera:Simuliidae*). The Natural History Museum, London, 144 pp.

Dadzie, Y., Hopkins, D.R. & Neira, M. 2002. Eds. *Final report of the conference on the eradicability of onchocerciasis*. The Carter Center, Atlanta, Georgia, January 22–24, v + 146 pp.

Dalmat, H.T. 1951. Notes on the Simuliidae (Diptera) of Guatemala, including descriptions of three new species. *Annals of the Entomological Society of America*, **44**: 31–58.

Dalmat, H.T. 1952. Descriptions of two new species of *Simulium* (Diptera, Simuliidae) from Guatemala. *Annals af the Entomological Society of America*, **45**: 339–347.

Dalmat, H.T. 1955. The black flies (Diptera, Simuliidae) of Guatemala and their role as vectors of onchocerciasis. *Smithsonian Miscellaneous Publications*, **125**: vii + 1–425.

D'Andretta, C. Jr., & D'Andretta, M.A.V. 1946. Corrigenda ao capítulo Simuliidae dos 'Estudios de Zoologia y Parasitologia Venezolanas' do Prof. A. Lutz. *Revista Brasileira de Biología*, **6**: 307–308.

Dampf, A. 1928. Un simúlido nuevo de México (Orden Diptera, Suborden Nematocera) procedente de Tiltepec, Estado de Oaxaca. *Revista Mexicana de Biología*, **7**: 125–130.

Dampf, A. 1931. Los simúlidos transmisores de la oncocercosis en los estados de Oaxaca y Chiapas. *Medicina, Revista Mexicana Quincenal*. **11**: 753–761.

De León, J.R. 1943. Preliminares para la descripción de cinco nuevas especies de simúlidos en Guatemala. *Boletin Sanitario de Guatemala*, **51**: 94–101.

De León, J.R. 1945a. Nuevas especies de simúlidos en la región occidental de Guatemala. *Boletin Sanitaria de Guatemala*, **52** (**1944**): 66–77.

De León, J.R. 1945b. *Nuevas especies de simúlidos en la región occidental de Guatemala*. Tipografía Nacional, Guatemala, pp.12.

De León, J.R. 1946. *Sobre la ecología de un nuevo grupo de especies de simúlidos*. Tipografía Nacional, Guatemala, pp. 3–11.

Dyar, H.G. & Shannon, R.C. 1927. The North American two-winged flies of the family Simuliidae. *Proceedings of the United States National Museum*, **69**: 1–54.

Enderlein, G. 1925. Weitere Beitäge zur Kenntnis der Simuliiden und Verbreitung. *Zoologischer Anzeiger*, **62**: 201–211.

Enderlein, G. 1934. Weiterer Ausbau des Systems der Simuliiden. (Dip.). *Deutsche Entomologische Zeitschrift*. **1933**: 273–292.

Fairchild, G.B. 1940. Notes on the Simuliidae of Panama (Dipt., Nematocera). *Annals of the Entomological Society of America*, **33**: 701–719.

Fairchild, G.B. 1943. An annotated list of the bloodsucking insects, ticks, and mites known from Panama. *American Journal of Tropical Medicine*, **23**: 569–591.

Field, G. 1969. Studies of black flies of Panama. III. Two new species of *Simulium* of the subgenus *Hemicnetha*. *Annals of the Entomological Society of America*, **62**: 157–163.

Fox, I. 1953. Notes on Puerto Rican Simuliidae from light traps (Diptera). *Proceedings of the Entomological Society of Washington*, **55**: 135–140.

Fundación Arias para la Paz y el Progreso Humano. 2000. *Migration and Integration in Belize: Realities and Respanses*. ix + 32pp. [http//www.arias.or.cr.].

Garnham, P.C.C. & Lewis, D.J. 1959. Parasites of British Honduras with special reference to leishmaniasis. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **53**: 12–40.

Grillet, M.E. & Barrera, R. 1997. Spatial and temporal abundance, substrate partitioning and species co-occurrence in a guild of Neotropical blackflies (Diptera:Simuliidae). *Hydrobialagía*, **345**: 197–208.

Grillet, M.E., Barrera, R. & Conn. J. 1995. *Simulium metallicum* cytospecies E larval habitat characterization in the Altamira focus of onchocerciasis, northern Venezuela. *Medical and Veterinary Entomology*, **9**: 195–201.

Hamada, N. & Fouque, F. 2001. Black flies (Diptera:Simuliidae) of French Guiana: cytotaxonomy and a preliminary list of species. *Memorias do Instituto Oswaldo Cruz*, **96**: 955–959.

Hamada, N. & Grillet, M.E. 2001. Black flies (Diptera:Simuliidae) of the Gran Sabana (Venezuela) and Pacaraima Region (Brazil): distibutional data and identification keys for larvae and pupae. *Entomotropica*, **16**: 29–45.

Hirai, H. & Uemoto, K. 1983. The analysis of salivary gland chromosomes of *Simulium ochraceum* from Guatemala and Mexico. *Japanese Journal of Sanitary Zoalogy*, **34**: 120.

Hirai, H. & Uemoto, K. 1984. Polytene chromosome analysis in *Simulium metallicum* complex from Guatemala. *Japanese Journal of Sanitary Zoology*. **35**: 188. [In Japanese]

Hoffmann, C.C. 1930a. Un *Simulium* nuevo de la zona cafetera de Chiapas. *Anales del Instituto de Biología de la Universidad Nacional Autónoma de México*, **1**: 51–53.

Hoffmann, C.C. 1930b. Los simúlidos de la región onchocercosa de Chiapas (con descripción de nuevas especies). *Anales del Instituto de Biología de la Universidad Nacional Autónoma de México*, **1**: 293–301.

Hoffman, C.C. 1931. Los simúlidos de la región oncocercosa de Chiapas. *Anales del Instituto de Biología de la Univesidad Nacional Autónoma de México*, **2**: 207–218.

Homan, E.J., Zuluaga, F.N., Yuill, T.M. & Lorbacher de R., H. 1985. Studies on the transmission of Venezuelan Equine Encephalitis virus by Colombian Simuliidae (Diptera). *American Jaurnal of Tropical Medicine and Hygiene*, **34**: 799–804.

Ibáñez Bernal, S. 1992. *Las especies Mexicanas de Simulium* (*Henicnetha*) *and S.* (*Natolepria*) (*Diptera: Simuliidae*). 297 pp. M.S. Thesis, Universidad Autónoma de México, México D.F.

International Commission on Zoological Nomenclature. 2000. *International Code of Zoological Nomenclature*, 4th Edition, The Internatioanl Trust for Zoological Nomenclature, xix + 273 pp.

Iriarte, D.R. 1983. *The Simuliidae family in Venezuela* [*364–430*]. In *Scientific Works*. Ediciones Universal, Miami, Florida, 544 pp. [Compendium of various publications of Iriarte and others.]

Iremonger, S. & Brokaw, N.V.L. 1995. *Vegetation Classification for Belize*. In *Towards a National Protected Area Systems Plan for*

Belize. Programme for Belize & Inter-American Development Bank, 50 pp.

Jennings, A. 1915. Two new species of Simuliidae from tropical America. *Proceedings of the Entomologicol Society of Washington*, **17**: 199–200

Johnson, M.S. & Chaffey, D.R. 1973. An inventory of the Chiquibul forest reserve, Belize. *Land Resource Study*, **14:** 1–25.

Knab, F. 1913. A note on some American Simulidae. *Insecutor Inscitiae Menstruus*, **1**: 154–156.

Knab, F. 1915. New data and species in Simuliidae. *Insecutor Inscitiae Menstruus*, **[1914] 2**: 177–180.

León, L.A. & Wygodzinsky, P. 1953. Los simúlidos del Ecuador y su importancia en medicina tropical (Diptera Simuliidae). *Revista Ecuotoriana de Entomología y Parasitología*, **1**: 23–39 + 2 unnumbered pages of figures.

Lewis, D.J. 1963. Simuliidae (Diptera) from the human onchocerciasis area of Venezuela. *Proceedings of tlie Royol Entomological Society of Londan*, **32**: 53–62.

Lewis, D.J. & Garnham, P.C.C. 1960. The Simuliidae (Diptera) of British Honduras. *Bulletin of Entomological Research*, **50**: 703–710.

Lewis, D.J. and Iháñez Aldecoa. 1962. Simuliidae and their relation to human onchocerciasis in northern Venezuela. *Bulletin of tlie World Health Organization*, **27**: 449–464.

Loew, H. 1862. Diptera Americae septentrionalis indigena. Centuria secunda. *Berliner Entomologische Zeischrift*, **6**: 185–232. [Later republished (pp. 55–102) in 1864 in *Diptero Americae septentrionalis indigena*. **1** (*Centuriae* 1–5): 266 pp Berlin [1861].].

Lundell, C.L. 1937. The Vegetation of Petén. *Publications of the Carnegie Institute Washington*, **478**: i–ix,1–244.

Lutz, A. 1917. Terçeira constribuição para conhecimento das espécies brasileiras do gênero '*Simulium*'. O piúm do norte (*Simulium omozonicum*). *Memórias do Instituto Oswoldo Cruz*, **9**: 63–67.

Lutz, A. 1928. *Estudios de Zoología y Parasitología Venezolanos*. Pp. 133 + 26 plates. Rio de Janeiro.

Maes, J.-M. 1990. Catálogo de los Diptera de Nicaragua. 7. Simuliidae (Nematocera). *Revista Nicaraguense de Entomología*, **148**: 19–22.

Malloch, J.R. 1912. One new genus and eight new species of dipterous insects in the United States National Museum collection. *Proceedings of tlie United States Nationol Museum*, **43**: 649–658 + 1 plate.

Malloch, J.R. 1914. American black flies or buffalo gnats. *Technical Series of the Bureau of Entomolagy of tlie United States*, **26**: 1–71 + 6 plates.

Millest, A.L. 1989. *The Simulium ochraceum and S. metollicum species complexes in Mexico; identification, distribution and relation to onchocerciasis*. 113 pp. + appendices. PhD thesis, University of Southampton, UK.

Millest, A.L. 1990. Differences in the larval head patterns and body coloration of members of the *Simulium metollicum* complex (Diptera:Simuliidae) from Mexico. *Bulletin of Entomologicol Research*, **80**: 191–194.

Millest, A.L., Cheke, R.A. & Greenwood, R. 1999. Distribution of the *Simulium metallicum* complex in Mexico in relation to selected environmental variables. *Medical and Veterinary Entomology*, **13**: 139–149.

Muhammad, A. 1988. *A cytologicol description of Simulium virgatum Coquillett and reloted species*. 93 pp + 19 figs. on un-numbered pages. M.S. thesis, Sul Ross State University, Alpine, Texas.

Muñoz de Hoyos, P. 1994. Simuliidae (Diptera) de Colombia: distribución de las especies registradas. *Revisto de la Acodemio Colombiano de Ciencio*, **19**: 413–437.

Okazawa, T. & Onishi, O. 1980. Description of a new species of *Simulium* (*Simulium*) Latreille and redescription of *Simulium* (*Simulium*) *metollicum* Bellardi from Guatemala (Diptera:Simuliidae). *Japanese Journal of Sanitary Zoology*, **31**: 167–179.

Onishi, O., Okazawa, T. & Ochoa A., J.O. 1977. Clave gráfica para la identificación de los simúlidos del área de San Vicente Pacaya, por los carácteres externos de larvas y pupas. *Guatemala-Japan Cooperation Research and Control Program of Onchocerciasis, Malaria Eradicotion Nationol Service and Adjainted Programs*, **2**: 1–11.

Ortiz, I. 1944. *Simulium quadrivittatum* Loew. Su presencia en Venezuela. *Revisto del Instituto Bacteriológico del Deportoniento Nacional de Hygiene*, **4**: 737–742.

Penn, M.G. 1995. Life on Earth: GIS at the Natural History Museum. *GIS Europe*, **4**: 20–24.

Penn, M. & Furley, P.A. 1998. *Spatial anolysis of forest composition, productivity and micra-environmental variotion in Belize: a pilot study*. The Natural History Museum, London, 4pp.

Petersen, J.L. 1982. Population genetics of some New World Simuliidae. Pp. 628–642. In *Recent developments in the genetics of insect disease vectors*. Eds., Steiner, W.W.M., Tabachnick, W.J., Rai, K.S. & Narang, S. Stipes Publishing Co., Champaign, Illinois.

Petersen, J.L., Adames, A.J. & De León, L. 1983. Bionomics and control of black flies (Diptera:Simuliidae) at the Fortuna hydroelectric project, Panama. *Journol of Medicol Entomology*, **20**: 399–408.

Peterson, B.V. 1993. The black flies of the genus *Simulium*, subgenus *Psilopelnuio* (Diptera:Simuliidae), in the contiguous United States. *Journol of the New York Entomolagical Society*, **101**: 301–390.

Peterson, B.V., Vargas, M. & Ramírez Pércz, J. 1988. *Simulium* (*Hemicnetlia*) *hieroglyphicum* (Diptera: Simuliidae), a new black fly species from Costa Rica. *Proceedings of tlie Entomological Society of Washington*, **90**: 76–80.

Peterson, B.V. & Kondratieff, B.C. 1994. The black flies (Diptera:Simuliidae) of Colorado: an annotated list with keys, illustrations and descriptions of three new species. *Memoirs of tlie American Entomological Society*, **42**: 1–121.

Pinto, C. 1932. Simuliidae da America Central de do Sul. *Reunión de lo Sociedod Argentina de Patología Regional del Norte*, **[1931] 7**: 661–763 + i (corrigenda).

Procunier, W.S. 1989. Cytological approaches to simuliid biosystematics in relation to the epidemiology and control of human onchocerciasis. *Genome*, **32**: 559–569.

Py-Daniel, V. 1983. Caraterização de dois novos subgêneros em Simuliidae (Diptera:Culicomorpha) Neotropical. *Amazoniana*, **8**: 159–223.

Py-Daniel, V. & Moreira Sampaio R.T. 1994. Actualização nomenclatural para Simuliidae Neotropical (Diptera, Culicomorpha, Simuliidae). *Memorias del CAICET*, **4**: 149–156.

Ramírez Pérez, J. 1971. Distribución geográfica y revisión taxonómica de los simúlidos (Diptera:Nematocera) de Venezuela con descripción de diez especies nuevas. *Acta Biológica Venezolana*, **7**: 271–371.

Ramírez Pérez, J. 1977. Estudio sobre la morfología de *Simulium metallicum*, vector de la oncocercosis humana en Venezuela. *Publicación Científico* [Pan American Health Organization , Washington, D.C. USA], **338**: iii + 1–140.

Ramírez Pérez, J. 1983. *Los jejenes de Venezuela*. Simposio de oncocercosis americana. CAICET. Puerto Ayacucho [Venezuela], **15–17 Octubre, 1983**, iii + 156 pp.

Ramírez Pérez, J. & Vulcano, M.A. 1973. Descripción y resdescripciones de algunos simúlidos de Venezuela (Diptera: Simuliidae). *Archivos de Venezolanas de Medicina Tropical y Parasitología Médica*, **5**: 375–399.

Roubaud, M.E. 1906a. Simulies nouvelles de l'Amérique du Sud. *Bulletin du Muséum d'Histoire Noturelle*, **12**: 106–110.

Roubaud, M.E. 1906b. Insectes Diptères. Simulies nouvelles ou peu connues. *Bulletin du Muséum d'Histoire Naturelle*, **12**: 517–522.

Rubtsov, I.A. & Garcia Avila, I. 1972. Los simúlidos de Cuba (Diptera:Simuliidae). *Poeyano*, **96**: 1–39.

Schiller, E.L., Petersen, J.L., Shirazian, D. & Figueroa Marroquin, H. 1984. Morphogenesis of larval *Onchacerco valvulus* in the Panamanian blackfly, *Simulium quadrivittatum*. *American Journal of Tropical Medicine & Hygiene*, **33**: 410–413.

Shelley, A.J. 1988a. Vector aspects of the epidemiology of onchocerciasis in Latin America. *Annual Review of Entomology*, **33**: 337–366.

Shelley, A.J. 1988b. Biosystematics and medical importance of the *Simulium omazanicum* group and the *S. exiguum* complex in Latin America. Pp. 203–220, In Service, M.W. (Ed.), *Biosystematics of*

haemataphagous Insects. xi + 363pp. Oxford University Press, Oxford.

Shelley, A.J. 1991. Simuliidae and the transmission and control of human onchocerciasis in Latin America. *Cadernas de Saúde Pública*, **7**: 310–327.

Shelley, A.J. & Arzube, M. 1985. Studies on the biology of Simuliidae (Diptera) at the Santiago onchocerciasis focus in Ecuador, with special reference to the vectors and disease transmission. *Transactions of the Rayal Society of Tropical Medicine and Hygiene*, **79**: 328–338.

Shelley, A.J., Arzube, M. & Couch, C.A. 1989. The Simuliidae (Diptera) of the Santiago onchocerciasis focus in Ecuador. *Bulletin of the British Museum of Natural History (Entamolagy series)*, **58**: 79–130.

Shelley, A.J., Lowry, C.A., Maia-Herzog, M., Luna Dias, A.P.A. & Moraes, M.A.P. 1997. Biosystematic studies on the Simuliidae (Diptera) of the Amazonia onchocerciasis focus of Brazil. *Bulletin of the Natural History Museum (Entomalogy series)*, **66**: 1–121.

Shelley, A.J., Luna Dias, A.P.A. & Maia-Herzog, M. 1984. New specific synonymy in Neotropical *Simulium s.l.* (Diptera:Simuliidae). *Memarias do Instituta Oswaldo Cruz*, **79**: 143–161.

Shelley, A.J., Luna Dias, A.P.A., Maia-Herzog, M., Lowry, C.A., Garritano, P.R., Penn., M. & Camargo, M. 2001. *Simulium cuasiexiguum*, a new blackfly species (Diptera:Simuliidae) from the Minaçu area in the State of Goiás, Central Brazil. *Memorias da Instituta Oswaldo Cruz*, **96**: 483–496.

Shelley, A.J., Maia-Herzog, M., Lowry, C.A., Luna Dias, A.P.A., Garritano, P.R., Shelley, A., Camargo, M. & Carter, H.G. 2000. The Simuliidae (Diptera) of the secondary onchocerciasis focus at Minaçu in central Brazil. *Bulletin of The Natural Histary Museum (Entomolagy series)*, **69**: 171–221.

Shelley, A.J., Pinger, R.R. & Moraes, M.A.P. 1982. The taxonomy, biology and medical importance of *Simulium amazonicum* Goeldi (Diptera:Simuliidae), with a review of related species. *Bulletin af the British Museum of Natural History (Entamalagy series)*, **44**: 1–29.

Smart, J. 1940. Simuliidae (Dipt.) from British Guiana and the Lesser Antilles. *The Transactians of the Royal Entomolagical Society af London*, **90**: 1–11.

Smart, J. 1945. The classification of the Simuliidae (Diptera). *The Transactians of the Royal Entomological Society of Londan*, **95**: 463–532.

Speiser, P. 1904. Zur nomenclature blutsaugender dipteren Amerikas. *Insekten Börse*, **21**: 148.

Stains, G.S. & Knowlton, G.F. 1943. A taxonomic and distributional study of Simuliidae of Western United States. *Annals of the Entomological Society of America*, **36**: 259–280.

Stone, A. 1948. *Simulium virgatum* Coquillett and a new related species (Diptera:Simuliidae). *Journal of the Washingtan Academy of Sciences*, **38**: 399–404.

Stone, A. 1969. The black flies of Dominica (Diptera: Simuliidae). *Praceedings of the Entamological Society of Washingtan*, **71**: 312–318.

Stone, A., Sabrosky, C.W., Wirth, W.W., Foote, R.H. & Coulson, J.R. 1965. *Family Simuliidae* (pp.181–189). In *A catalag af the Diptera af America Narth af Mexica*. United States Department of Agriculture, 1549 pp.

Streider, M.N. & Py-Daniel, V. 2000. Revisão de *Inaequalium* (Diptera, Simuliidae), com redescrição das formas imaturas e descrição de uma nova espécie. *Entomolagía y vectares*, **7 (supplement 2)**: i + 1–91.

Tada, I. 1983. Ed. *A camparative study af anchacerciasis between Central and Sauth Americas*. Matsubase, Shimomashikigun, Kumamoto, Japan:Shimoda, 79pp.

Tada, I. 1985. Ed. *A camparative study af anchacerciasis between Central and Sauth Americas*. Matsubase, Shimomashikigun, Kumamoto, Japan: Shimoda, 80pp

Tada, I. 1987. Ed. *A camparative study af anchacerciasis between Central and Sauth Americas*. Matsubase, Shimomashikigun, Kumamoto, Japan:Shimoda, 109pp.

Takaoka, H. 1982. Observations on the bionomics of larval and man-biting female populations of *Simulium horacioi*, a new potential vector of *Onchocerca valvulus* in Guatemala. *Japanese Journal of Tropical Medicine and Hygiene*, **10**: 49–62.

Takaoka, H., Suzuki, H., Noda, S., Tada, I., Rodulfo, S., Pachano, L. & Convit, J. 1984. Susceptibility of *S. metallicum* to infection with *O. volvulus* in Venezuela. *Japanese Journal of Tropical Medicine and Hygiene*, **12**: 89–96.

Tang, J., Pruess, K., Cupp, E.W. & Unnasch, T.R. 1996. Molecular phylogeny and typing of blackflies (Diptera:Simuliidae) that serve as vectors of human or bovine onchocerciasis. *Medical and Veterinary Entomalogy*, **10**: 228–234.

Travis, B.V., Vargas., V.M. & Swartzwelder, J.C. 1974. Bionomics of black flies (Diptera:Simuliidae) in Costa Rica. 1. Species biting man, with an epidemiological summary for the western hemisphere. *Revista de Biolagía Trapical*, **22**: 187–200.

Vargas, L. 1942a. Notas sobre la terminalia de algunos simúlidos de México. *S. (E). paynei* n. n. Vargas, 1942. *Revista del Instituta de Salubridad y Enfermedades Tropicales*, **3**: 229–249 + 4 un-numbered pages of figures.

Vargas, L. 1942b. *Simulium fairchildi* Vargas, 1942 n. n., de Panamá: Dipt. Simuliidae. *Revista Medicina de México*, **22**: 458–459.

Vargas, L. 1943. Nuevos datos sobre simúlidos mexicanos (Dip. Simuliidae). *Revista del Instituta de Salubridad y Enfermedades Trapicales*, **4**: 359–370.

Vargas, L. 1945. Simúlidos del Nuevo Mundo. *Monografías del Instituta de Salubridad y Enfermedades Tropicales, México*, **I**: vi + 241 pp.

Vargas, L. & Díaz Nájera, A. 1951. Notas sobre sistemática y morfología de simúlidos. *Revista del Instituto de Salubridad y Enfermedades Tropicales*, **12**: 123–172.

Vargas, L. & Díaz Nájera, A. 1953. *Simulium (Notalepria) gonzalezi* n. sp. *Revista del Instituto de Salubridad y Enfermedades Trapicales*, **13**: 235–241.

Vargas, L. & Díaz Nájera, A. 1954. Algunas consideraciones morfológicas y de nomenclatura relativas a simúlidos americanos (Diptera:Simuliidae). *Revista del Instituto de Salubridad y Enfermedades Tropicales*, **14**: 57–72 + 8 unnumbered pages of figures.

Vargas, L. & Díaz Nájera, A. 1956. *Simulium (Hemicnetha) guerrerense* n. sp. (Diptera:Simuliidae). *Revista del Instituto de Salubridad y Enfermedades Tropicales*, **16**: 51–56 + 2 un-numbered pages of figures.

Vargas, L. & Díaz Nájera, A. 1957. Simúlidos Mexicanos. *Revista del Instituto de Salubridad y Enfermedades Tropicales*, **17**: 143–399.

Vargas, L., Martínez Palacios, A. & Díaz Nájera, A. 1946. Simúlidos de México. *Revista del Instituto de Salubridad y Enfermedades Trapicales*, **7**: 101–192 + 25 plates.

Vulcano, M.A. 1967. *A catalague of the Diptera of the Americas sauth af the United States*. **16**. Family Simuliidae. 44 pp. São Paulo, Brazil.

Vulcano, M.A. 1981. Simuliidae. Pp. 275–285. In *Aquatic biata of Tropical South America. Part 1. Arthrapada*. Eds. Hurlbert, S.H., Rodriguez, G. & Dias dos Santos, N. San Diego State University, California.

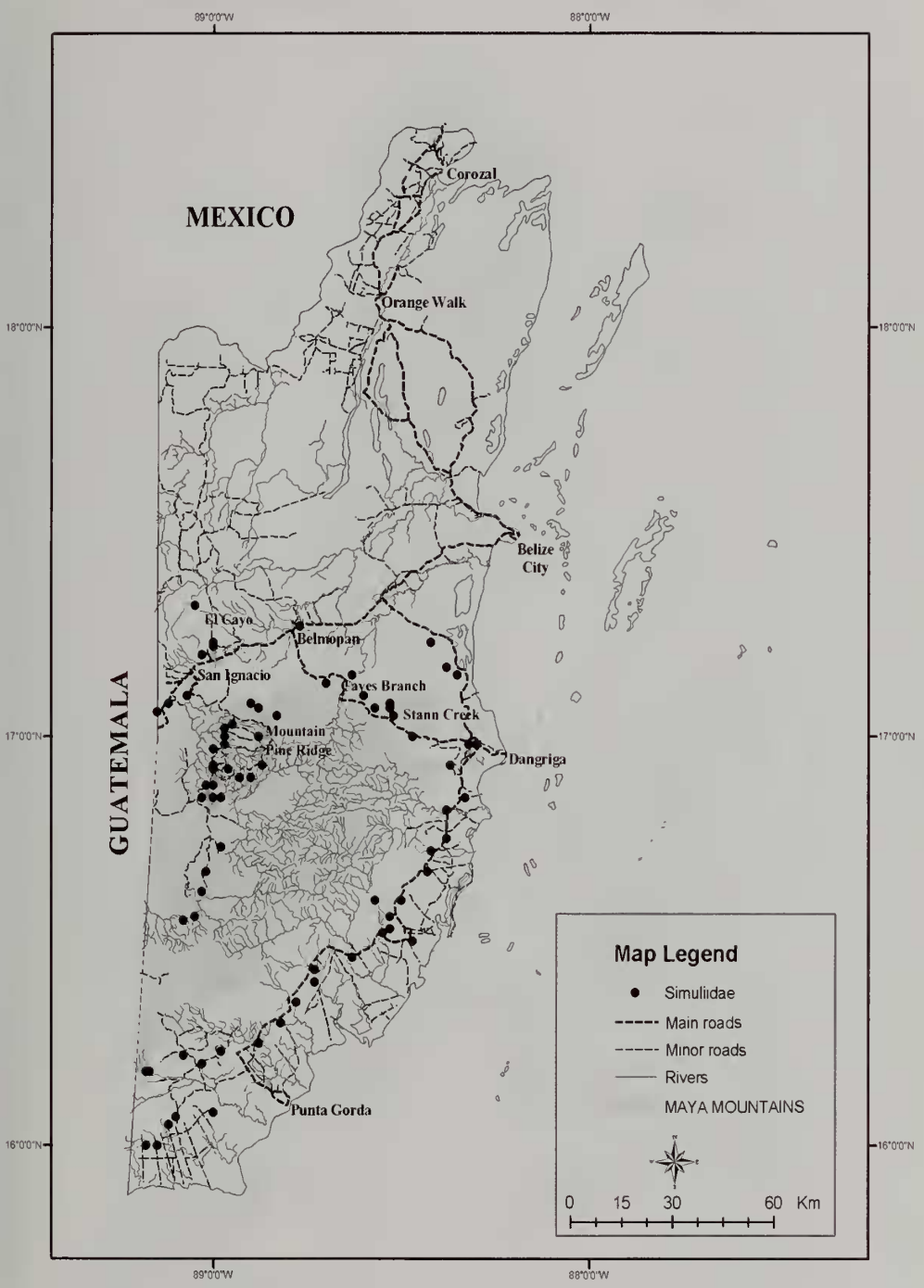
Wilson, R. 1995. Ed. *Tawards a natianal protected area systems plan for Belize*. Programme for Belize, Belize City, Belize. 75pp.

Walker, 1861. Characters of undescribed Diptera in the collection of W. W. Saunders, Esq., F. R. S. *Transactians af the Entamalagical Saciety af Londan* (n. s.), **5 (1858–1861)**: 268–334.

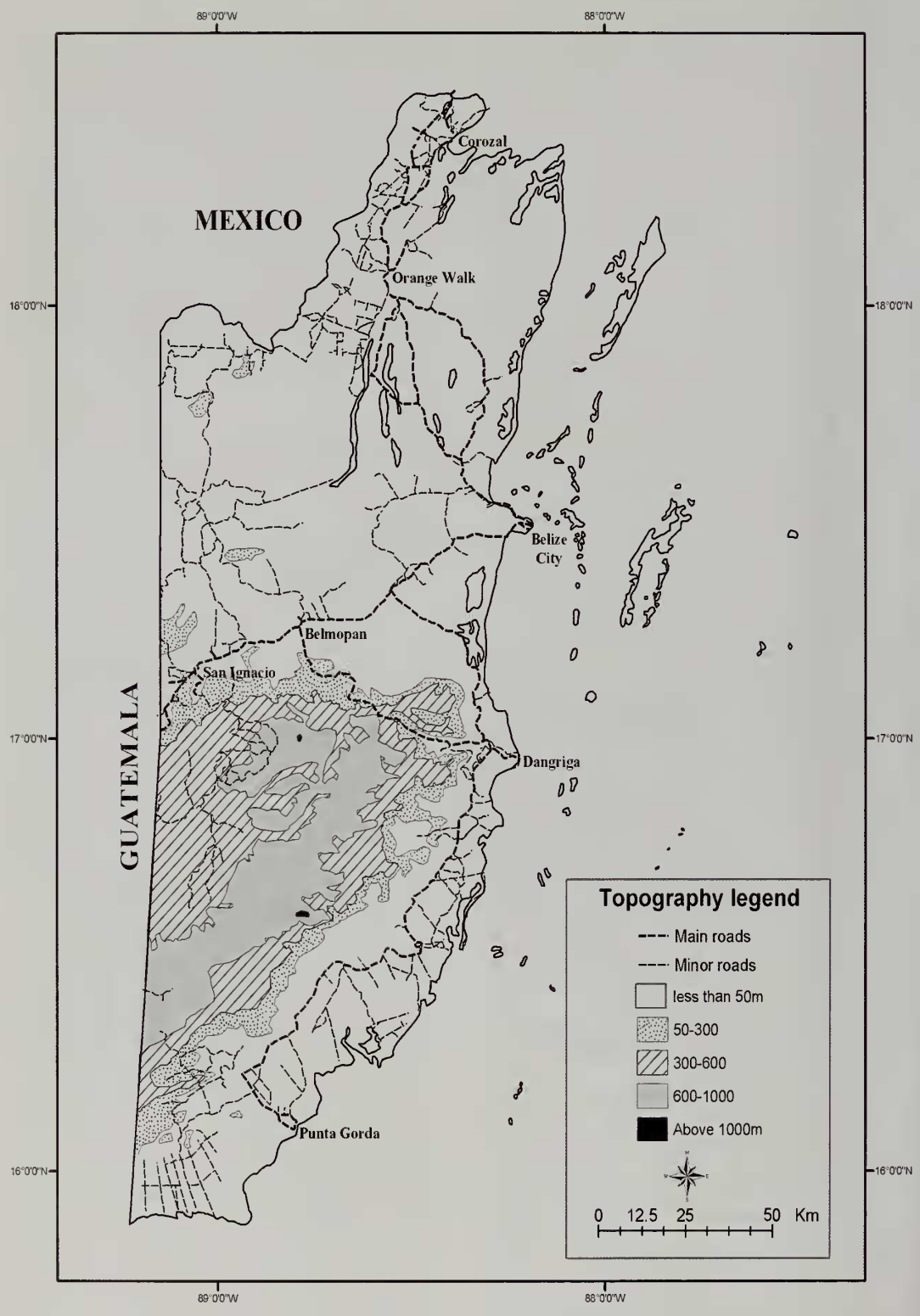
Wright, A.C.S., Romney, D.H., Arbuckle, R.H. & Vial, V.E. 1959. Land in British Honduras. Report of the British Honduras land use survey team. *Colanial Research Publicatians*, **24**: i–vii, 1–327.

Wygodzinsky, P. 1953. Sobre algunos simúlidos de los paises andinos (Diptera). *Anales del Instituta de Medicina Regianal de la Universidad Nacianal de Tucumán*, **3**: 321–337.

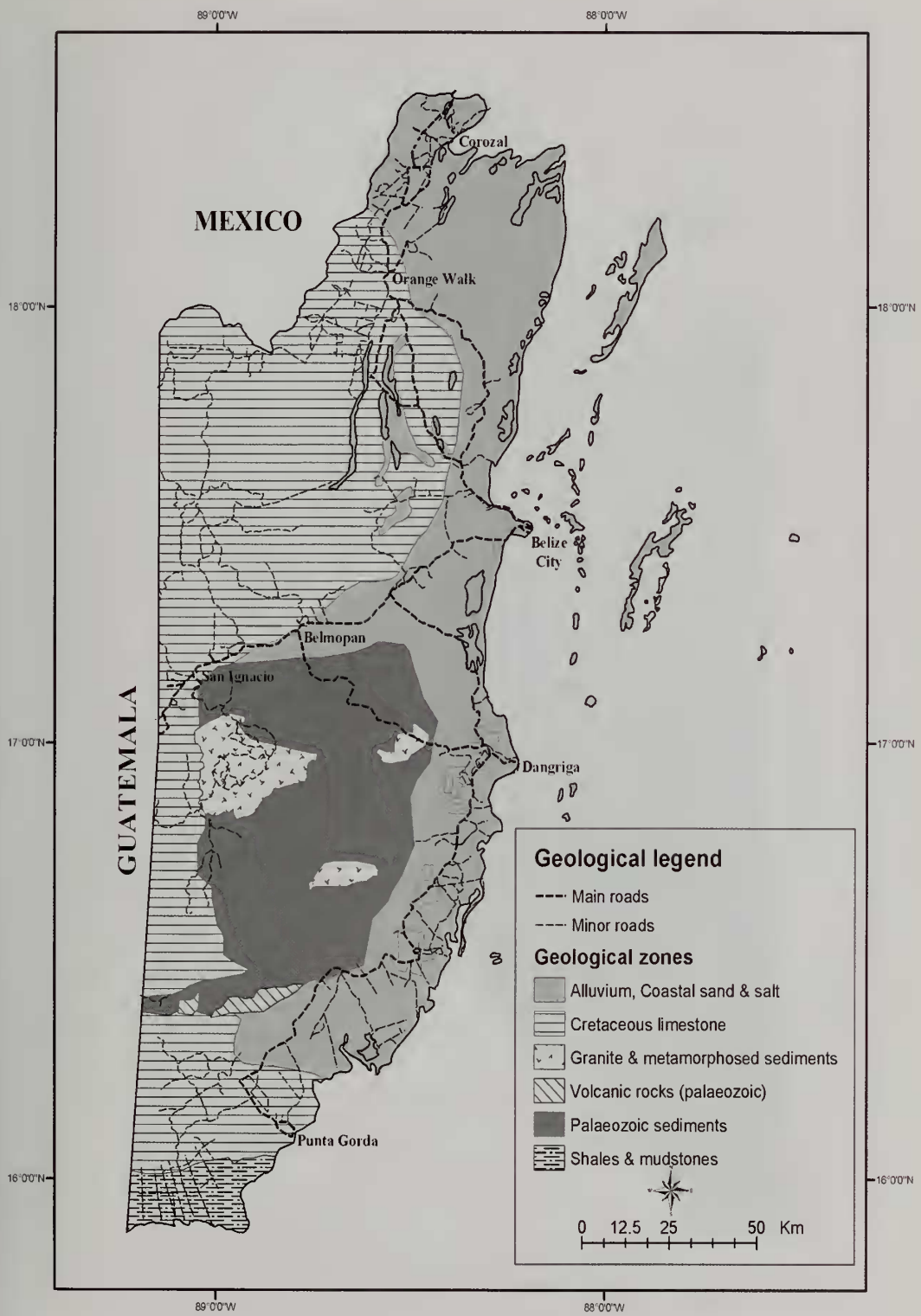
Wygodzinsky, P. 1971. Descriptions and redescriptions of species of the blackfly genus *Simulium* from the northern Andes (Simuliidae, Diptera). *American Museum Navitates*, **2447**: 1–38.



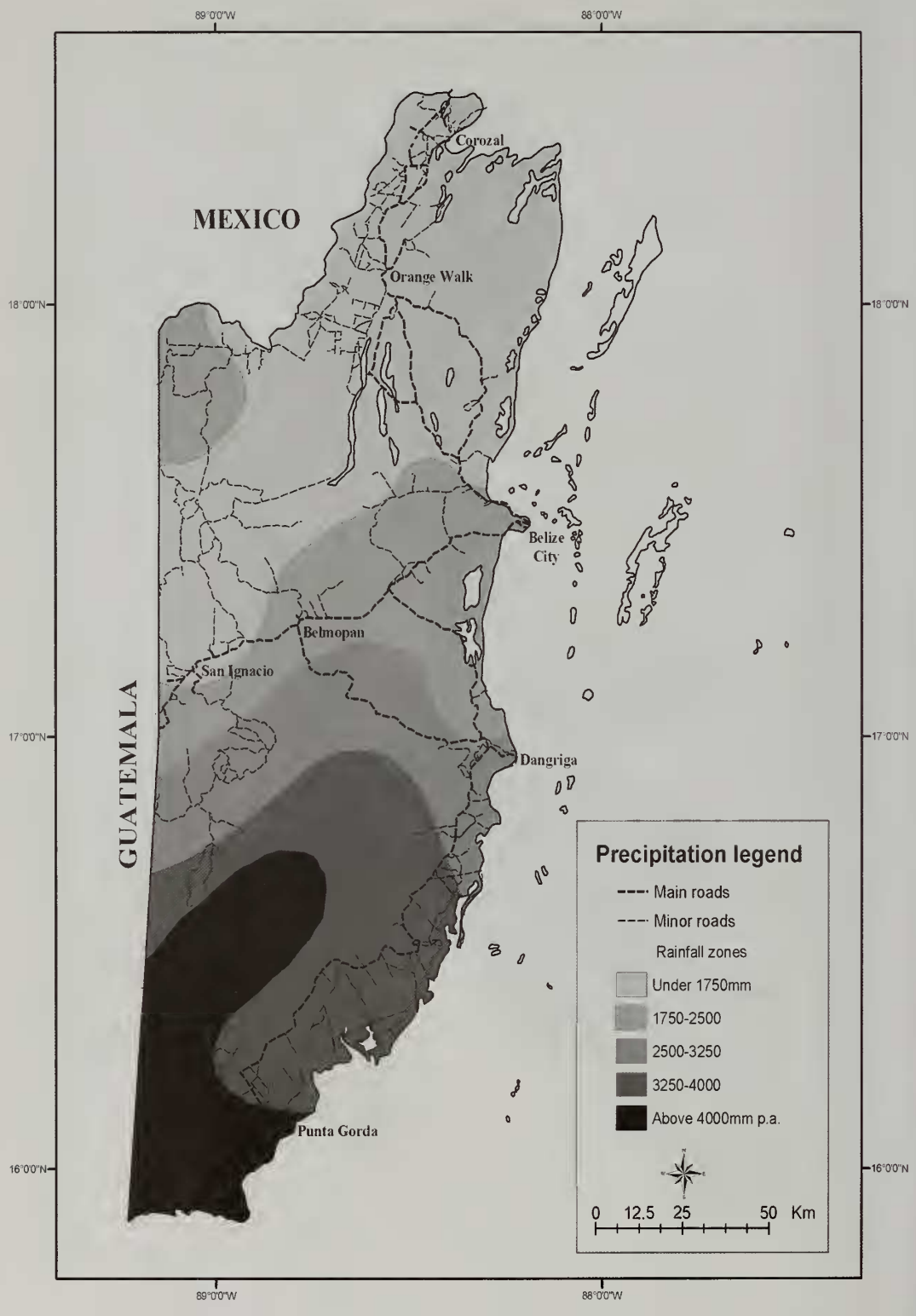
Map 1. Simuliidae collection localities in Belize



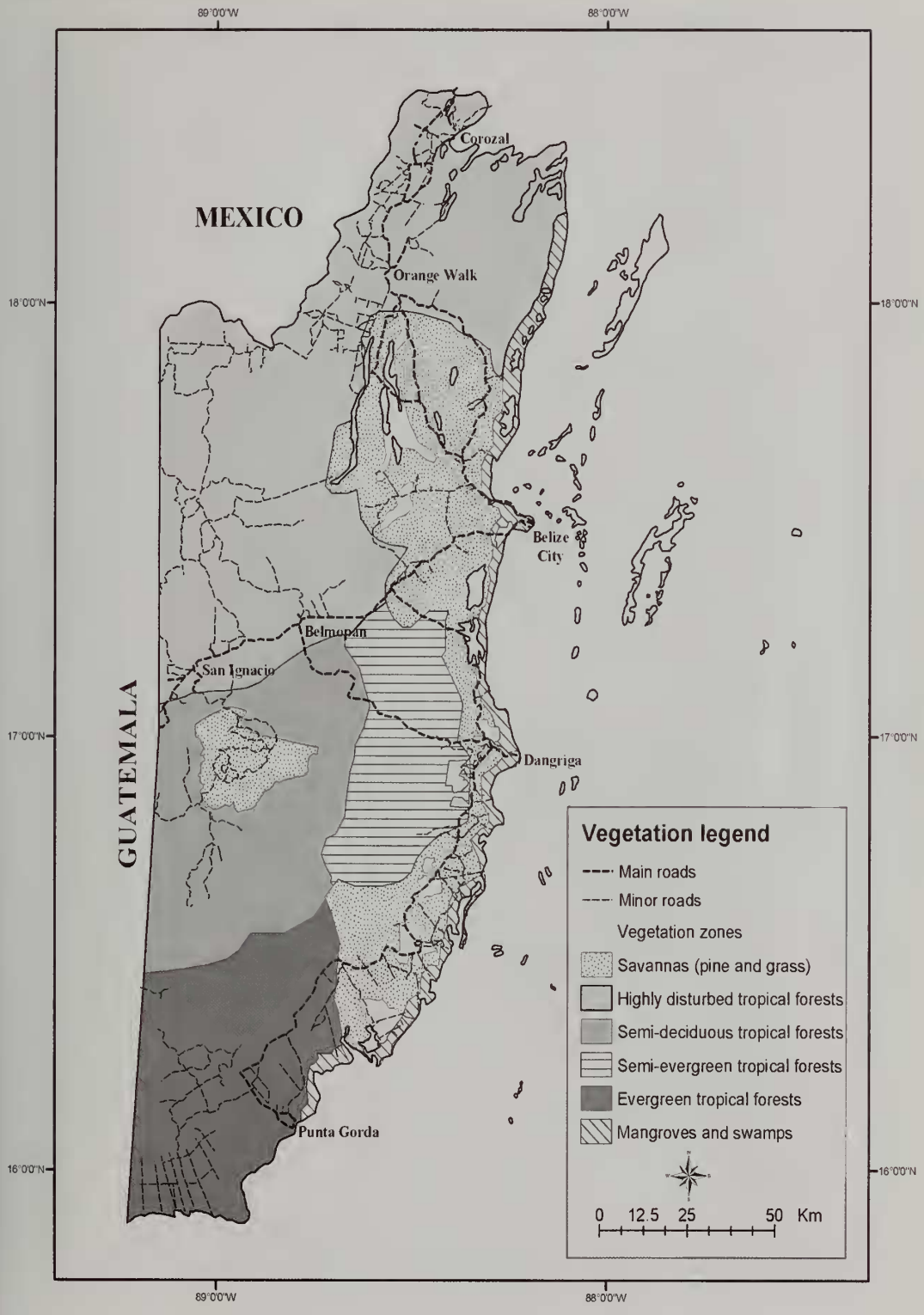
Map 2. Relief map of Belize.



Map 3. The main geological areas of Belize.

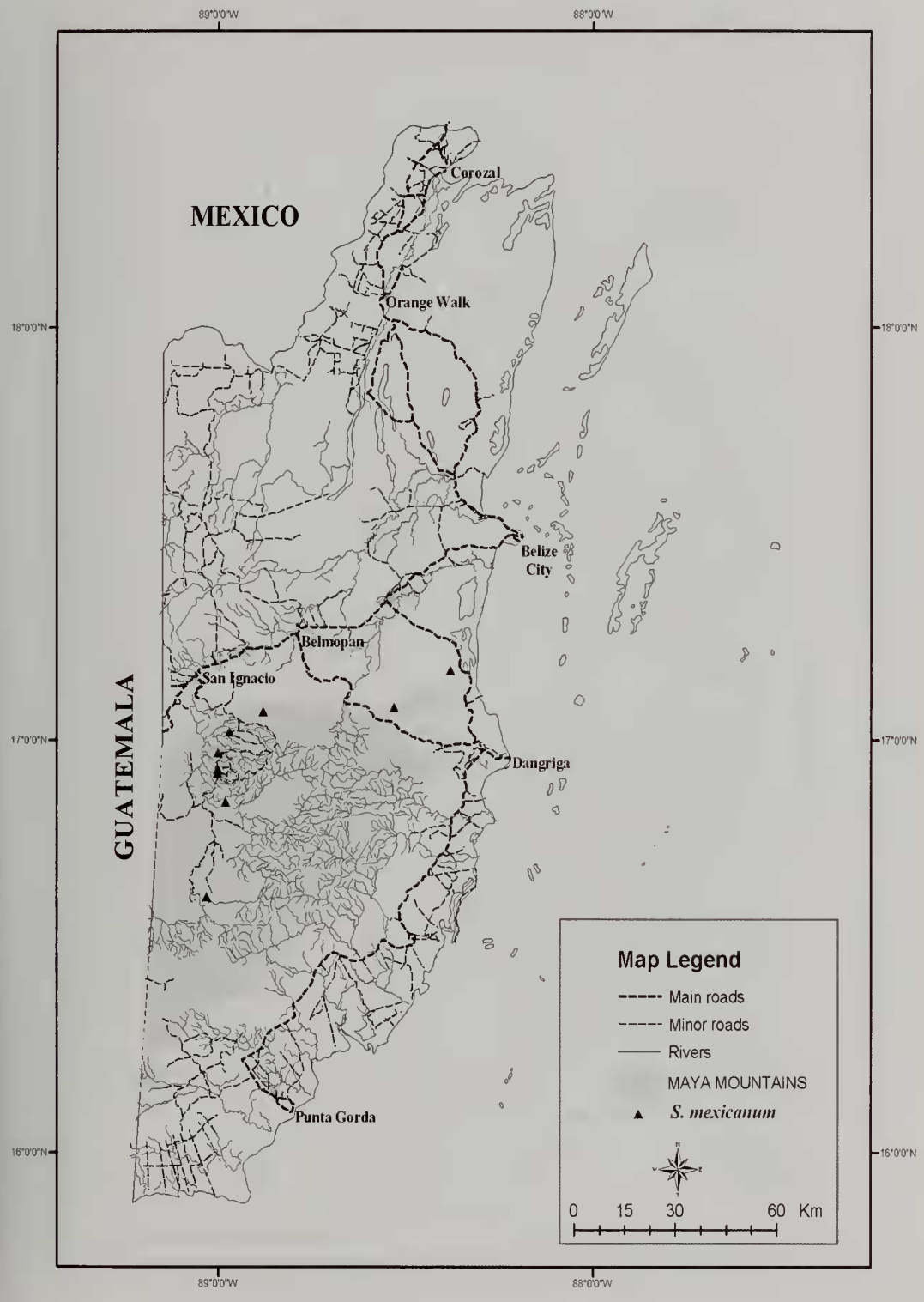


Map 4. Annual rainfall in Belize.



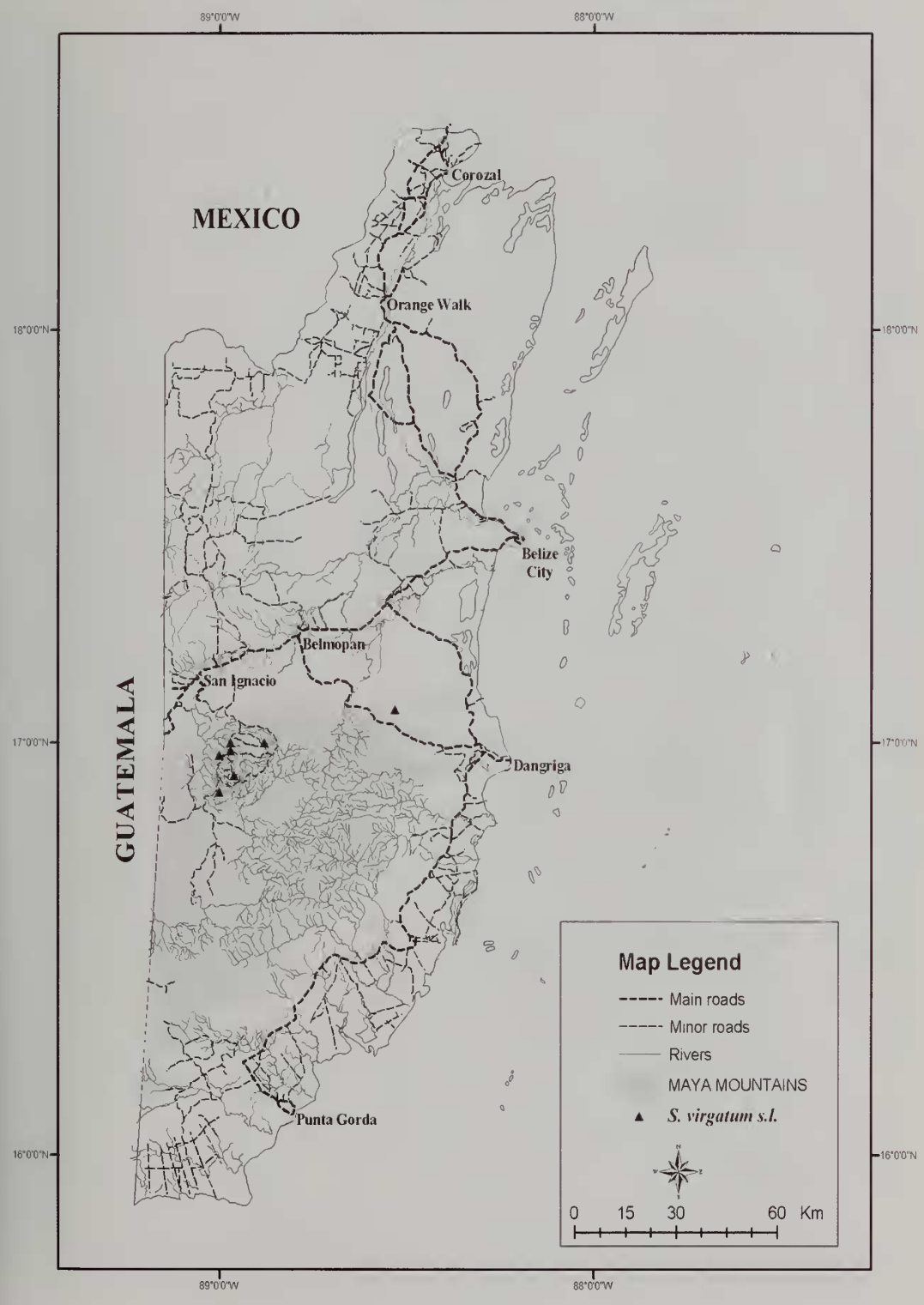
Map 5. The vegetation zones of Belize.

Map 6. The distribution of *S. earlei* in Belize.

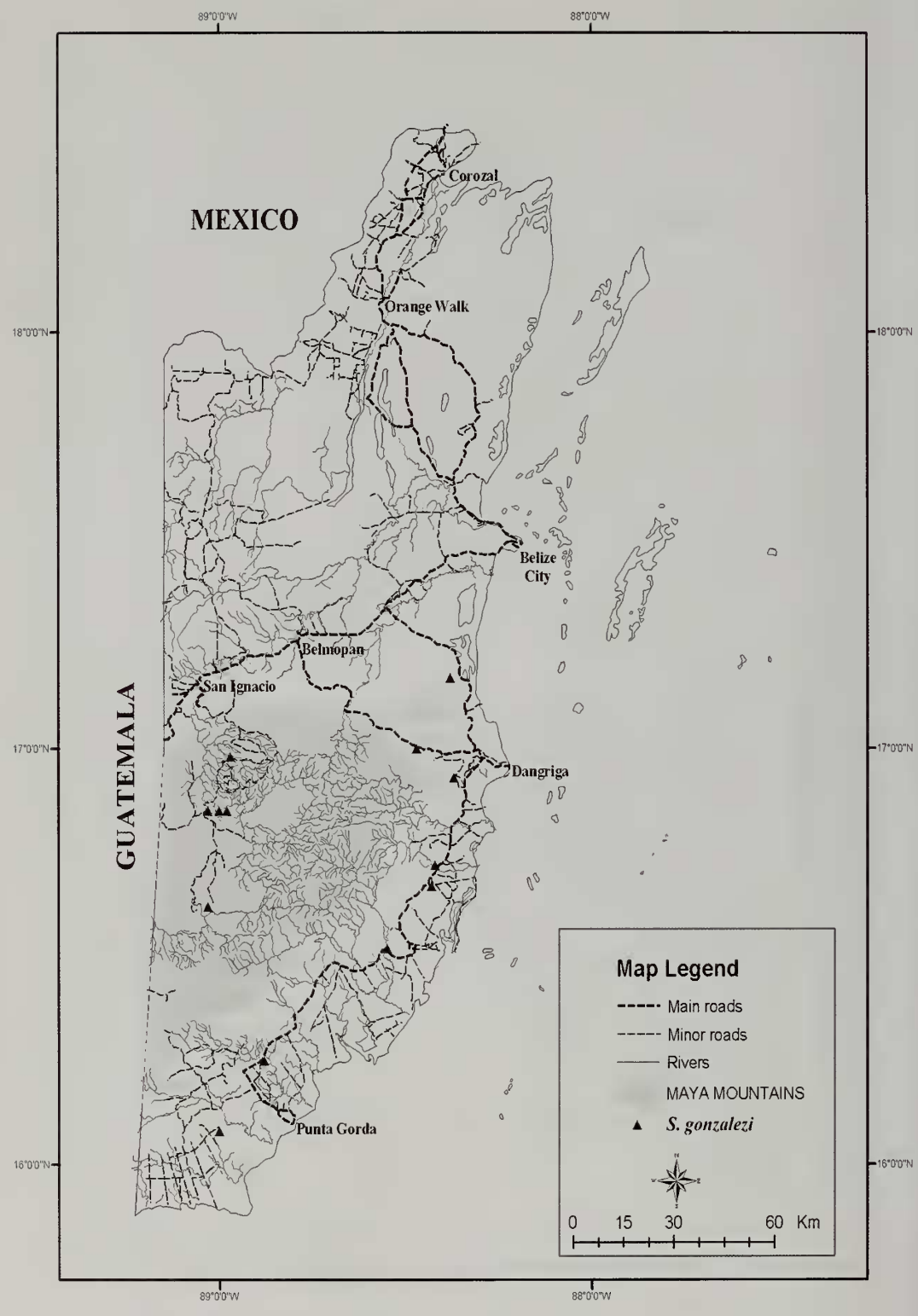


Map 7. The distribution of *S. mexicanum* in Belize.

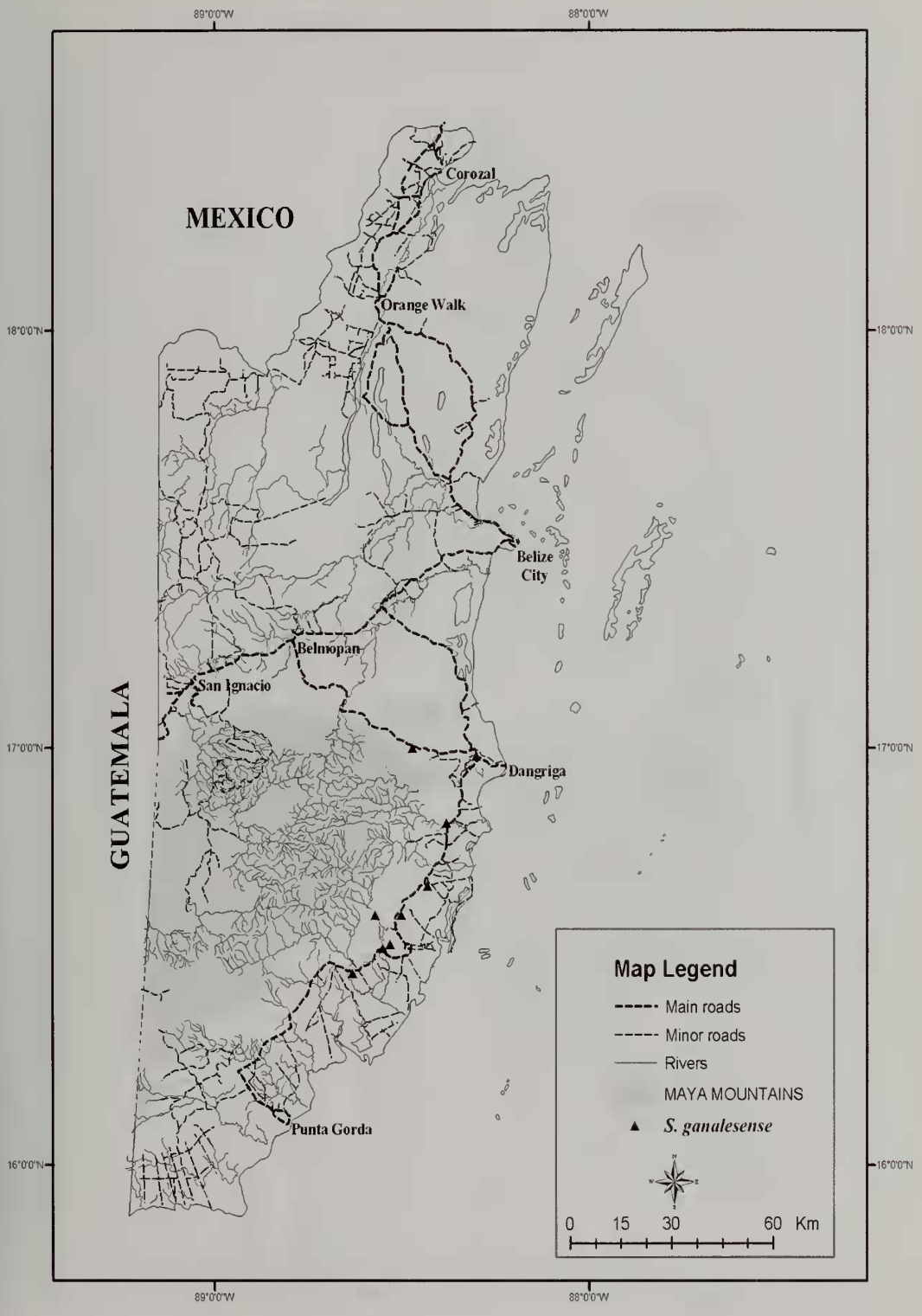
Map 8. The distribution of *S. pulverulentum* in Belize.



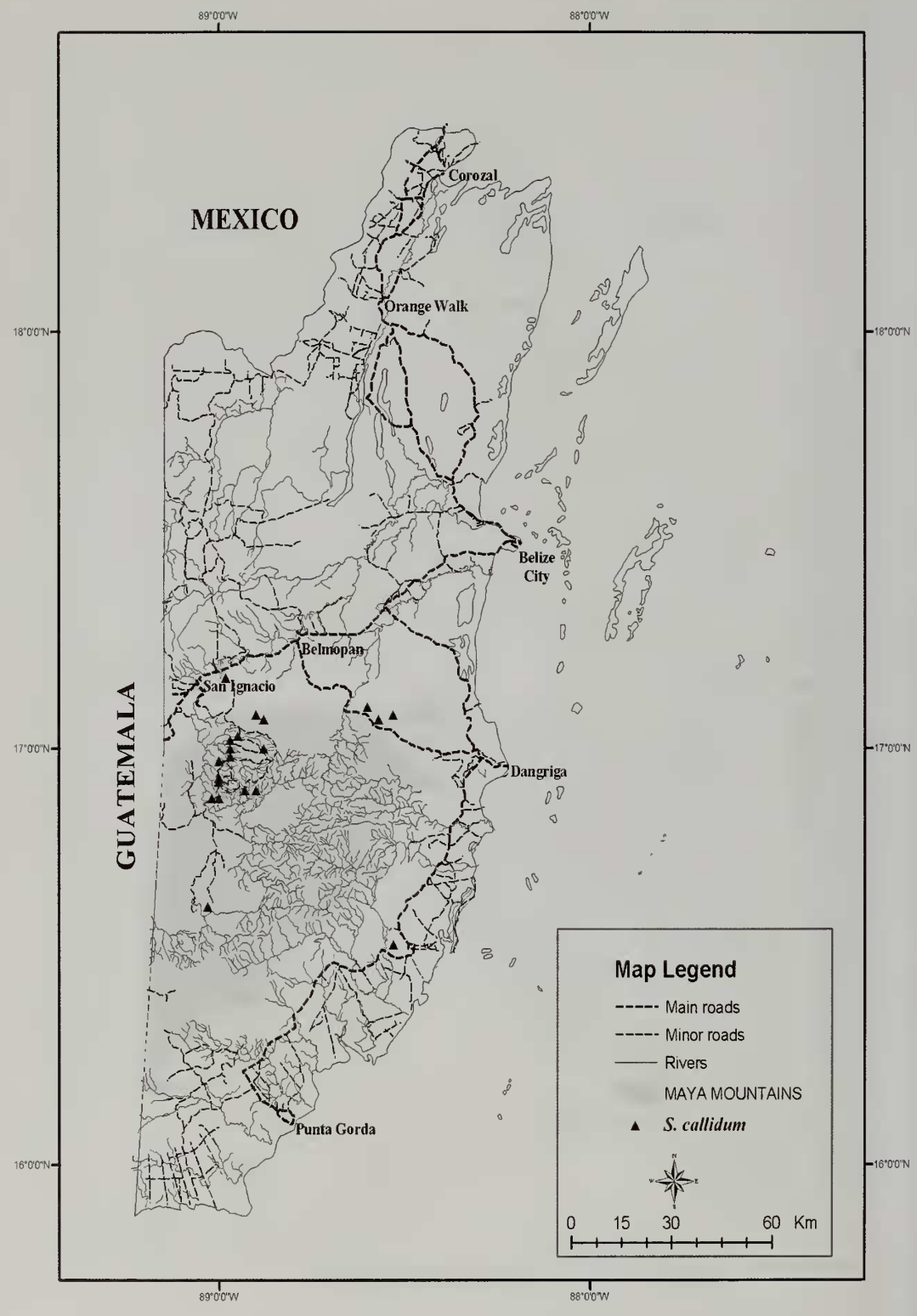
Map 9. The distribution of *S. virgatum s.l.* in Belize.



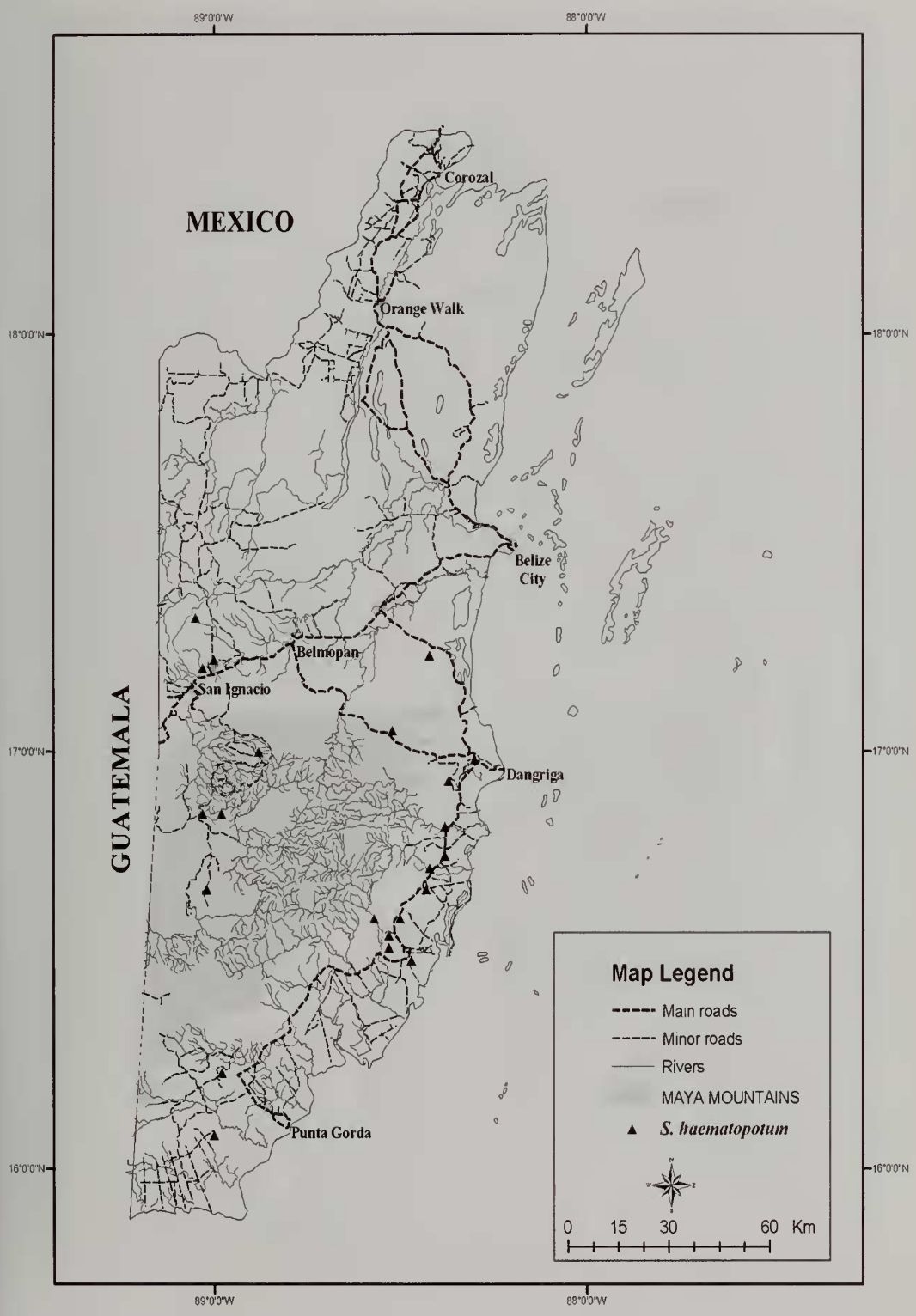
Map 10. The distribution of *S. gonzalezi* in Belize.



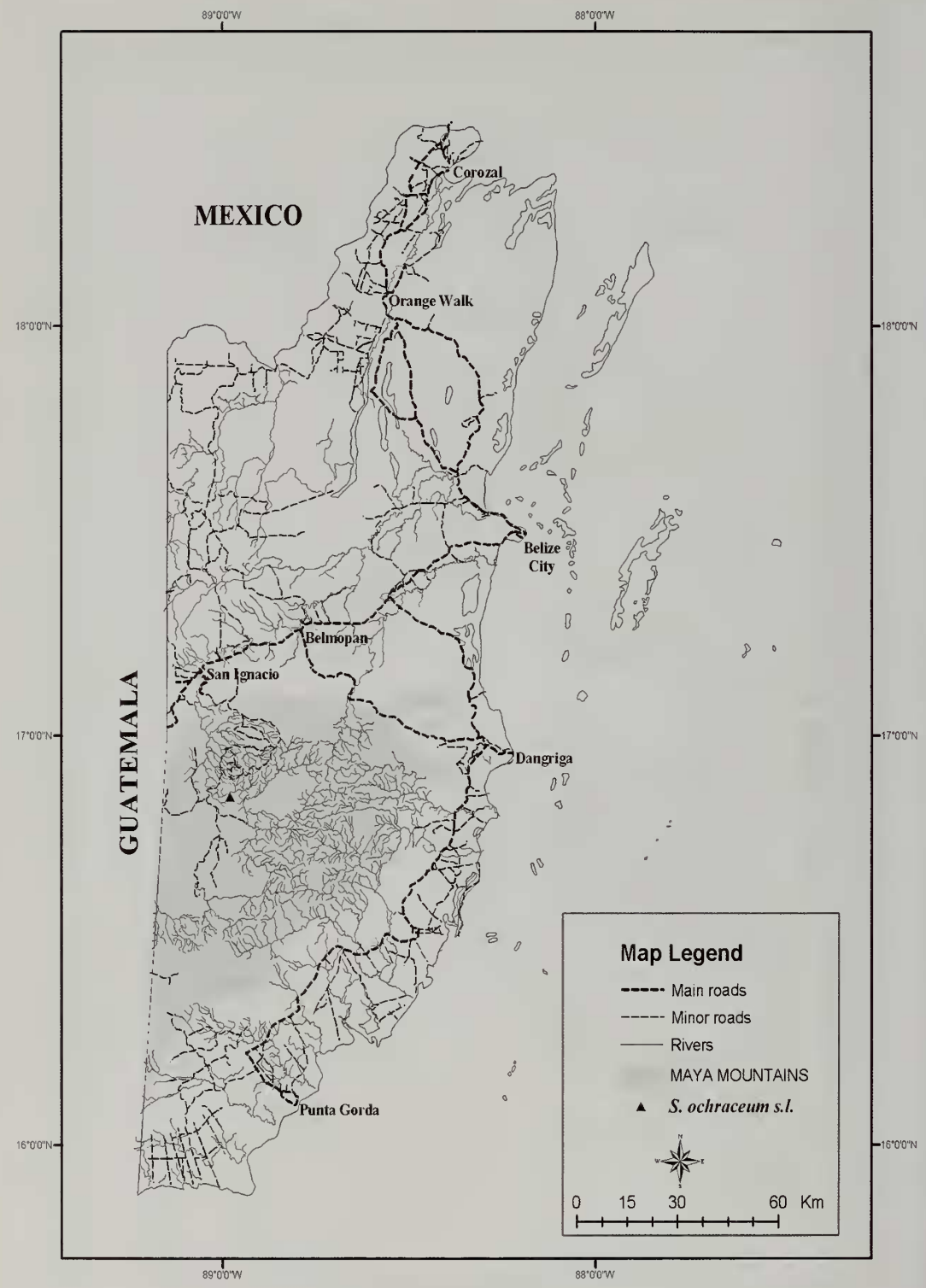
Map 11. The distribution of *S. ganalesense* in Belize.



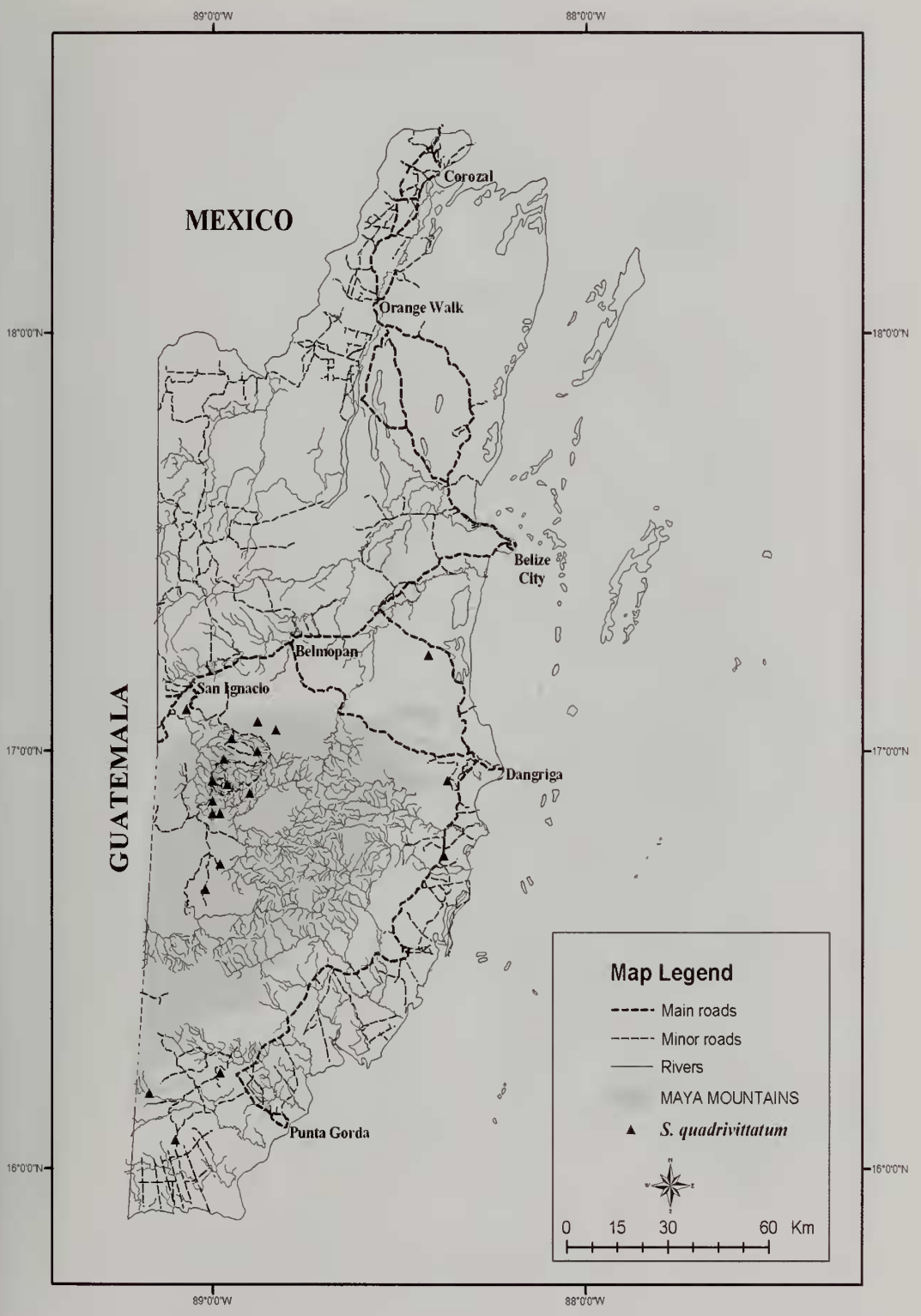
Map 12. The distribution of *S. callidum* in Belize.



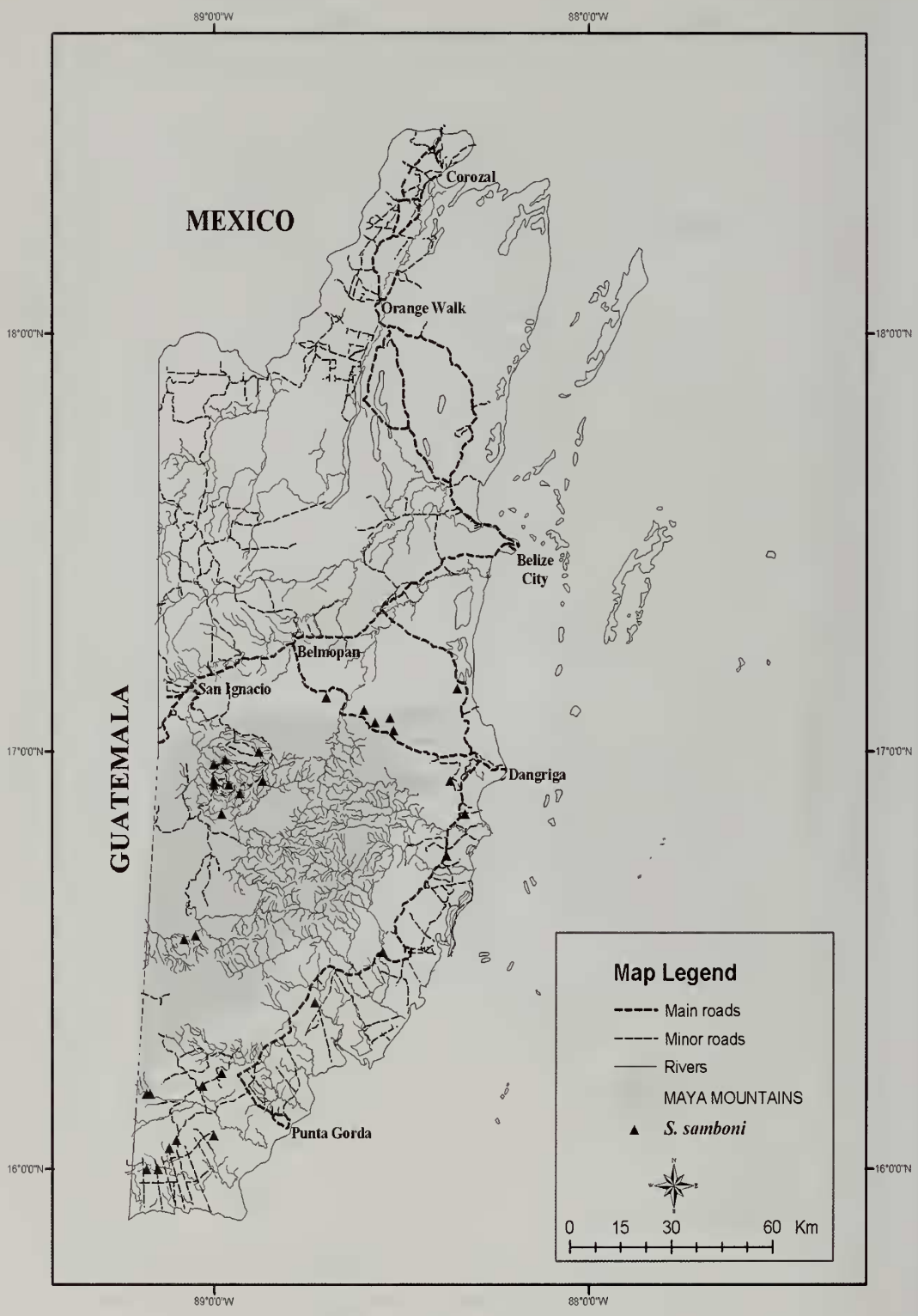
Map 13. The distribution of *S. haematopotum* in Belize.



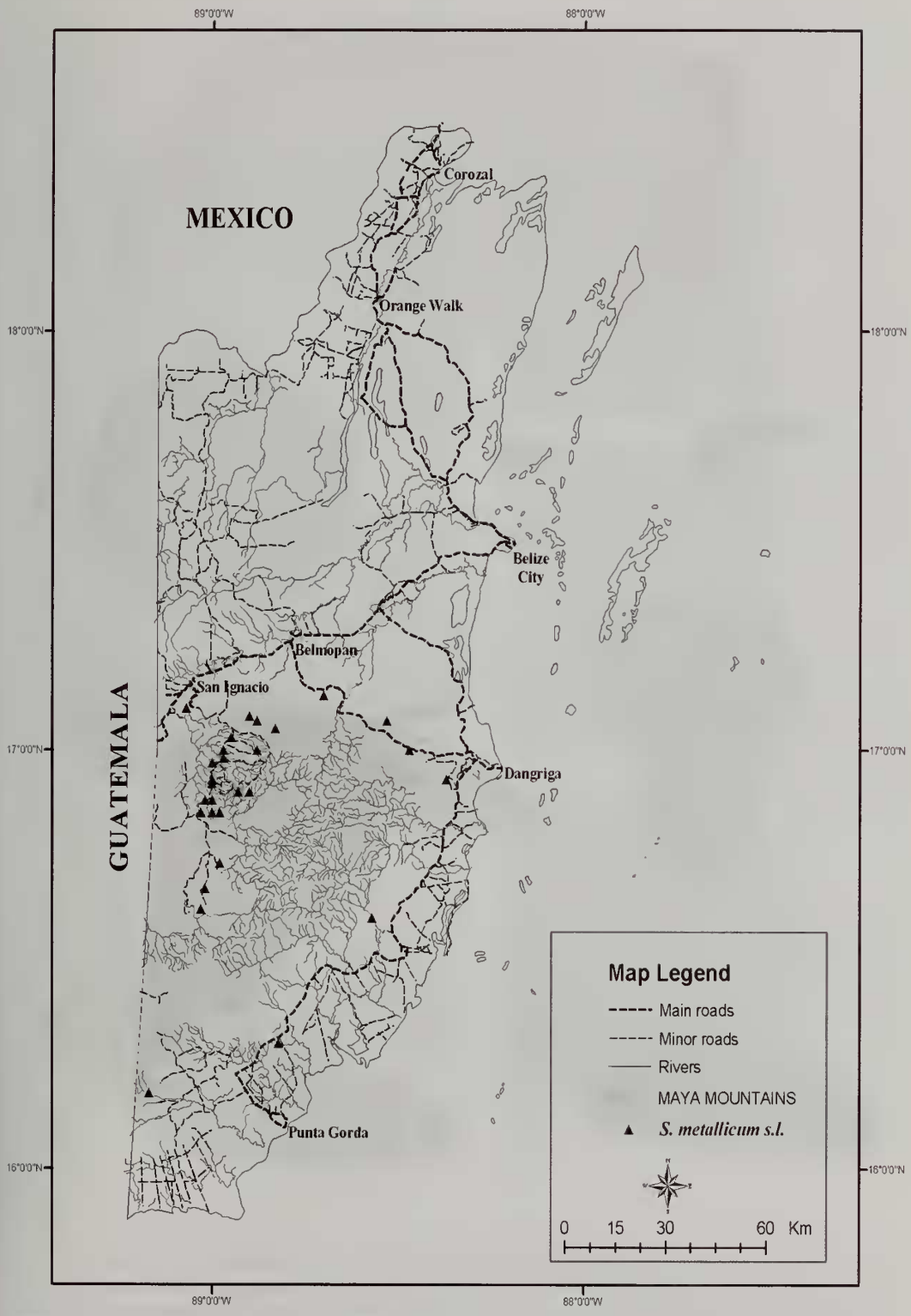
Map 14. The distribution of *S. ochraceum s.l.* in Belize.



Map 15. The distribution of *S. quadrivittatum* in Belize.



Map 16. The distribution of *S. samboni* in Belize.

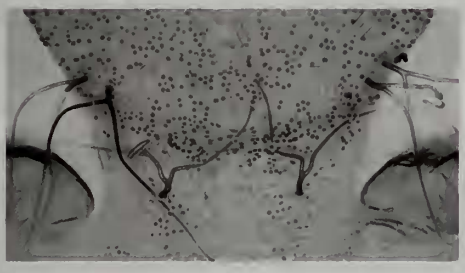


Map 17. The distribution of *S. metallicum s.l.* in Belize.

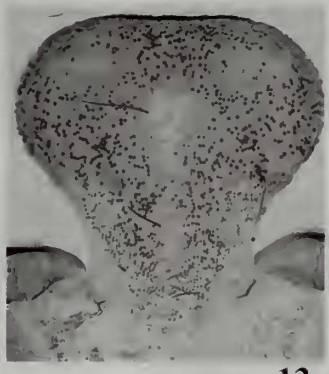
Figs 1–8. 1. Wing of *S. ochraceum s.l.* showing setae on Subcostal and basal section of Radius veins; 2. Claw of hind leg showing basal tooth of *S. virgatum s.l.*; 3. Claw of hind leg without basal tooth of *S. gonzalezi*; 4. Spermatheca of *S. quadrivittatum* showing membranous insertion of spermathecal duct; 5. Abdomen of male *S. pulverulentum* showing areas of silver pruinosity; 6. Slipper shaped cocoon of *S. callidum*; 7. Shoe shaped cocoon without fenestrations of *S. mexicanum*; 8. Shoe shaped cocoon with fenestrations of *S. virgatum s.l.*

9

12



10



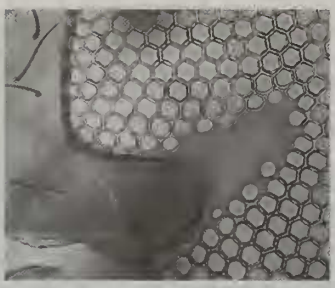
13

11

14

Figs 9–14. 9. Simple trichomes of frontoclypeus (head) of pupa of *S. earlei*; 10. Branched trichomes of frontoclypeus (head) of pupa of *S. metallicum s.l.;*11. Branched trichomes of thorax of pupa of *S.earlei* 12. Frontoclypeus (head) of female pupa of *S. gonzalezi* with sparse distribution of tubercles; 13. Frontoclypeus (head) of female pupa of *S. callidum* with dense distribution of tubercles; 14. Frontoclypeus (head) of male pupa *of S. earlei* with platelets .

15



16

17

18

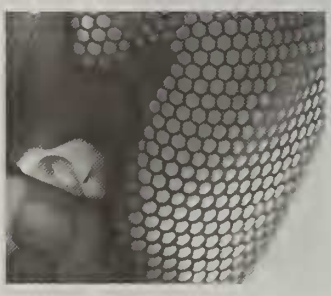
19

20

21

22

23

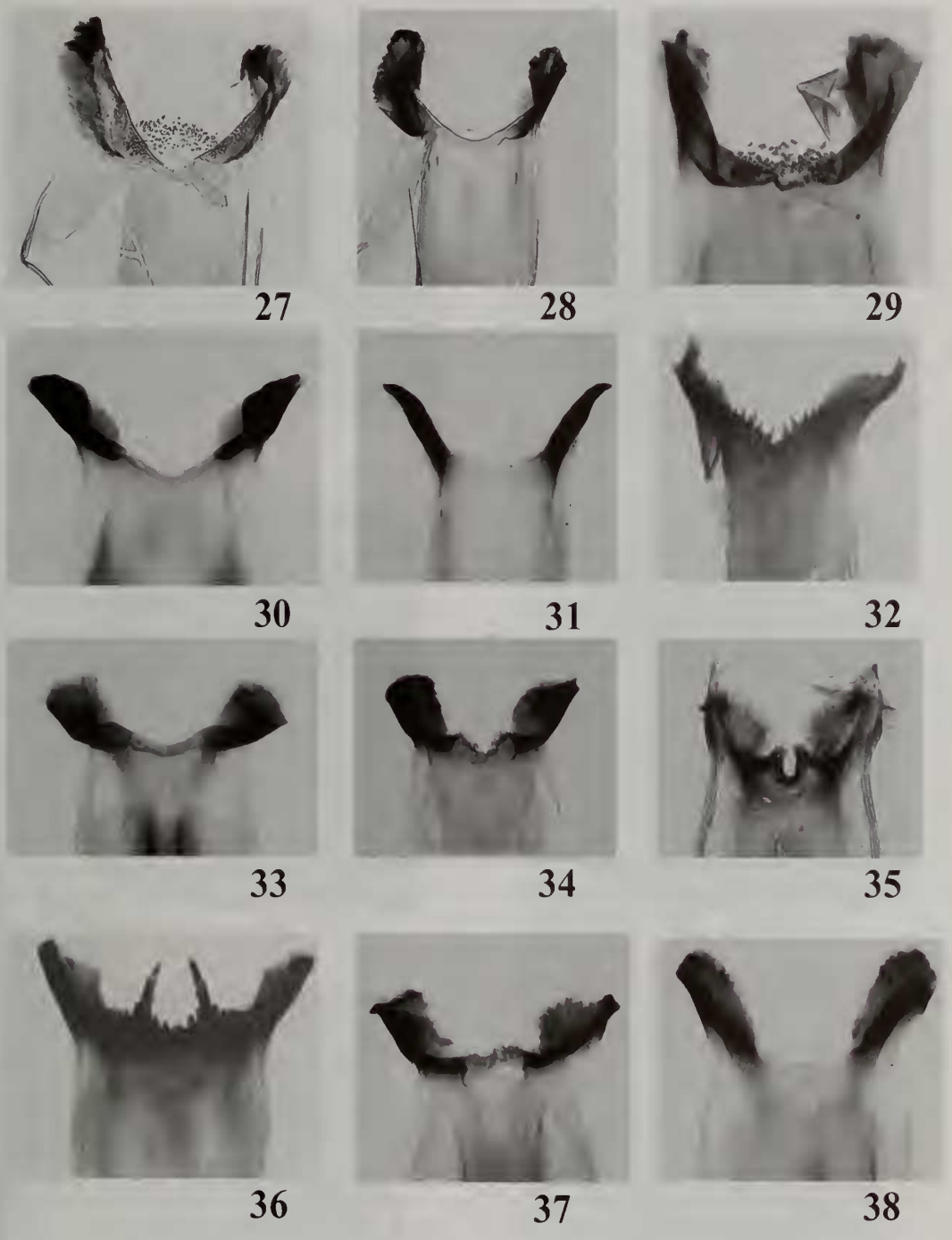


24

25

26

Figs 15–26. Nudiocular area of: 15. *S. earlei*; 16. *S. mexicanum*; 17. *S. pulverulentum*; 18. *S. virgatum s.l.*; 19. *S. gonzalezi*; 20. *S. ganalesense* Belize form; 21. *S. callidum*; 22. *S. haematopotum*; 23. *S. ochraceum s.l.*; 24. *S. quadrivittatum*; 25. *S. samboni*; 26. *S. metallicum s.l.*



Figs 27–38. Cibarium of: 27. *S. earlei*; 28. *S. mexicanum*; 29. *S. pulverulentum*; 30. *S. virgatum s.l.*; 31. *S. gonzalezi*; 32. *S. ganalesense* (Belize form); 33. *S. callidum*; 34. *S. haematopotum*; 35. *S. ochraceum s.l.*; 36. *S. quadrivittatum*; 37. *S. samboni*; 38. *S. metallicum s.l.*

39

40

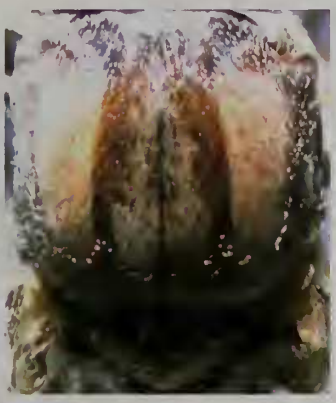
41

42

43

44

Figs 39–44. Colour patterns of the female thorax: 39. *S. earlei*, anterior illumination; 40. *S. earlei*, posterior illumination; 41. *S. mexicanum*, anterior illumination; 42. *S. mexicanum*, posterior illumination; 43, *S. pulverulentum*, anterior illumination; 44. *S. pulverulentum*, posterior illumination.



45

46

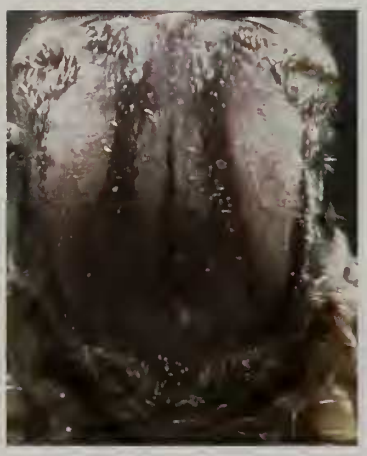
47

48

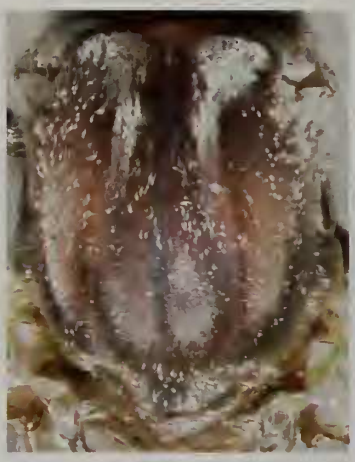
49

50

Figs 45–50. Colour patterns of the female thorax of: 45. *S. virgatum s.l.*, anterior illumination; 46. *S. virgatum s.l.*, posterior illumination; 47. *S. rubicundulum* (holotype), anterior illumination; 48. *S. rubicundulum* (holotype), posterior illumination; 49. *S. rubrithorax* (Brazil), anterior illumination; 50. *S. rubrithorax* (Brazil), posterior illumination.



51

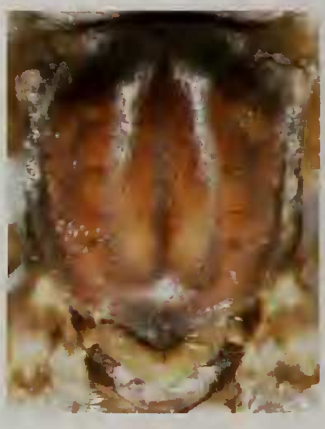


52

53

54

55



56

Figs 51–56. Colour patterns of the female thorax of: 51. *S. paynei* (Ecuador), anterior illumination; 52. *S. paynei* (Ecuador), posterior illumination; 53. *S. paynei* (as *S. acatenangoense*, Guatemala), anterior illumination; 54. *S. paynei* (as *S. acatenangoense*, Guatemala), posterior illumination; 55. *S. paynei* (as *S. mathesoni*, Mexico), anterior illumination; 56. *S. paynei* (as *S. mathesoni*, Mexico), posterior illumination.

57

58

59

60

61

62

Figs 57–62. Colour patterns of the female thorax of: 57. *S. gonzalezi*, anterior illumination; 58. *S. gonzalezi*, posterior illumination; 59. *S. ganalesense* (Belize form), anterior illumination; 60. *S. ganalesense* (Belize form), posterior illumination; 61. *S. ganalesense* (paratype), anterior illumination; 62. *S. ganalesense* (paratype), posterior illumination.

63

64

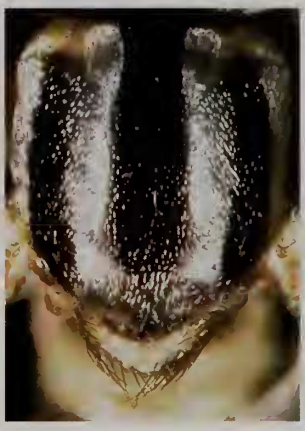
65

66

67

68

Figs 63–68. Colour patterns of the female thorax of: 63. *S. callidum*, anterior illumination; 64. *S. callidum*, posterior illumination; 65. *S. haematopotum*, anterior illumination; 66. *S. haematopotum*, posterior illumination; 67. *S. haematopotum* (lectotype), anterior illumination; 68. *S. haematopotum* (lectotype), posterior illumination;



Figs 69–74. Colour patterns of the female thorax of: 69. *S. veracruzanum*, anterior illumination; 70. *S. veracruzanum*, posterior illumination; 71. *S. ochraceum s.l.*, anterior illumination; 72. *S. ochraceum s.l.*, posterior illumination; 73. *S. ochraceum s.l.* neotype, anterior illumination; 74. *S. ochraceum s.l.* neotype, posterior illumination.

75

76

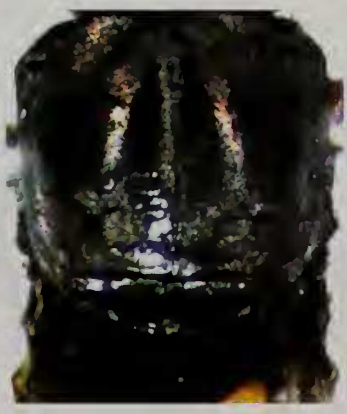
77

78

79

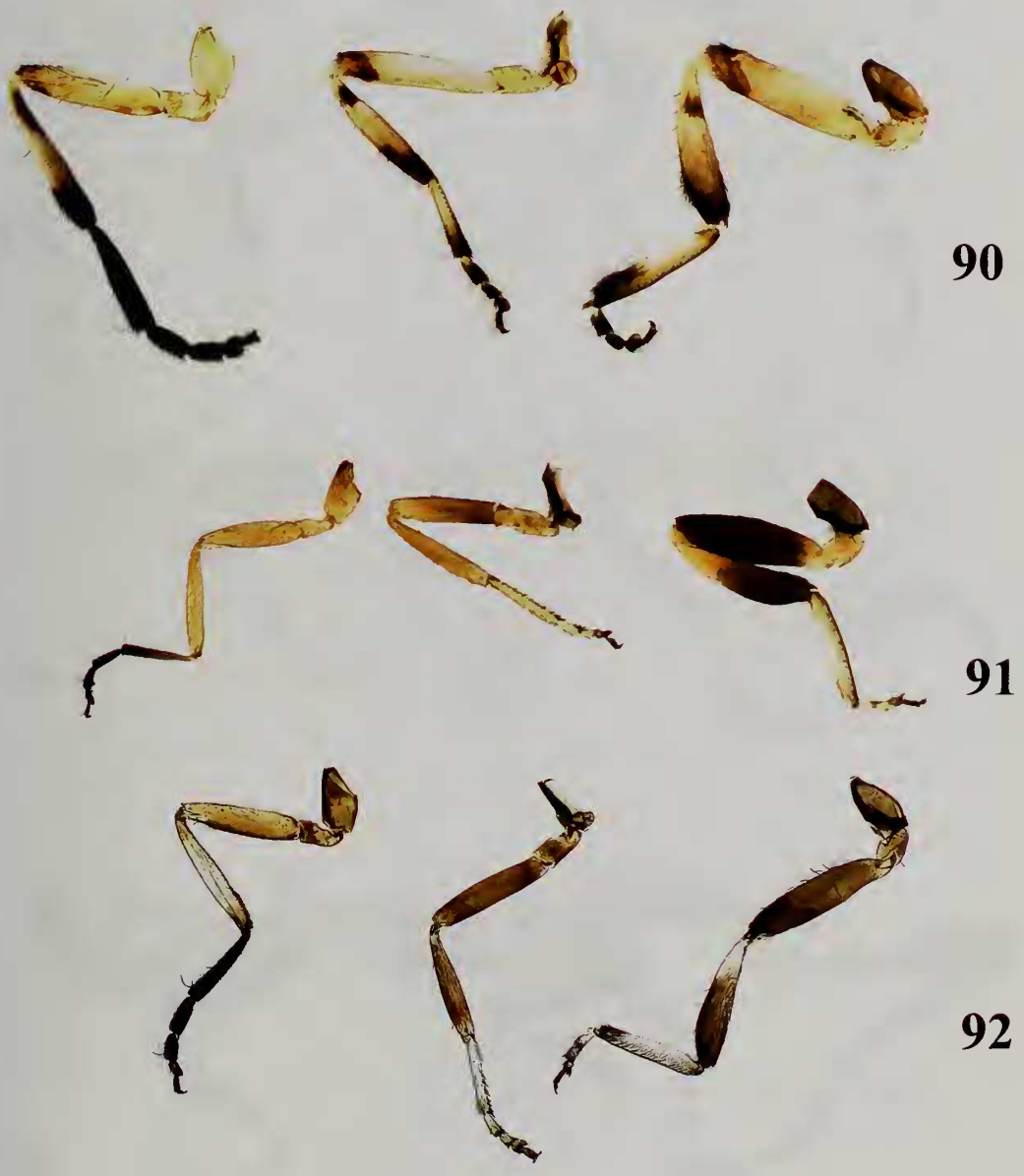
80

Figs 75–80. Colour patterns of the female thorax of: 75. *S. quadrivittatum,* anterior illumination; 76. *S. quadrivittatum*, posterior illumination; 77. *S. samboni*, anterior illumination; 78. *S. samboni*, posterior illumination; 79. *S. metallicum s.l.,* anterior illumination; 80. *S. metallicum s.l.*, posterior illumination.



Figs 81–86. Colour patterns of the female thorax of: 81. *S. metallicum s.l.* (wider vittae), anterior illumination; 82. *S. metallicum s.l.* (wider vittae), posterior illumination; 83. *S. metallicum s.l.* (merged vittae), anterior illumination; 84. *S. metallicum s.l.* (merged vittae), posterior illumination; 85. *S. metallicum* (holotype), anterior illumination; 86. *S. metallicum* (holotype), posterior illumination.

Figs 87–89. Colour patterns and proportions of legs of: 87. *S. earlei*; 88. *S. mexicanum*; 89. *S. pulverulentum.*



Figs 90–92. Colour patterns and proportions of legs: 90. *S. virgatum s.l.*; 91. *S. gonzalezi*; 92. *S. ganalesense* (Belize form).

93

94

95

Figs 93–95. Colour patterns and proportions of legs: 93. *S. callidum*; 94. *S. haematopotum*; 95. *S. ochraceum s.l.*

Figs 96–98. Colour patterns and proportions of legs: 96. *S. quadrivittatum*; 97. *S. samboni*; 98. *S. metallicum s.l.*

Figs 99–105. Colour patterns of the female abdomen of: 99. *S. earlei*; 100. *S. mexicanum*; 101. *S. pulverulentum*; 102. *S. virgatum s.l.*; 103. *S. gonzalezi*; 104. *S. ganalesense* (Belize form); 105. *S. callidum*.

106

107

108

109

110

111

Figs 106–111. Colour patterns of the female abdomen of: 106. *S. haematopotum*; 107. *S. veracruzanum*; 108. *S. ochraceum s.l.*; 109 *S. quadrivittatum*; 110. *S. samboni*; 111. *S. metallicum s.l.*

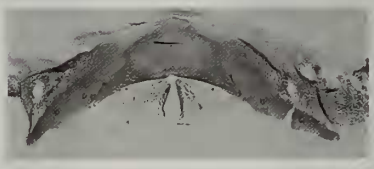
112

113

114

115

116



117

Figs 112–117. Eighth sternite and gonopophyses of: 112. *S. earlei*; 113. *S. mexicanum*; 114. *S. pulverulentum*; 115. *S. virgatum s.l.*; 116. *S. gonzalezi*; 117. *S. ganalesense* (Belize form).

118

119

120

121

122

123

Figs 118–123. Eighth sternite and gonopophyses of: 118. *S. callidum*; 119. *S. haematopotum*; 120. *S. ochraceum s.l.*; 121. *S. quadrivittatum*; 122. *S. samboni*; 123. *S. metallicum s.l.*

124

125

126

127

128

129

130

Figs 124–130. Cercus and paraproct of: 124. *S. earlei*; 125. *S. mexicanum*; 126. *S. pulverulentum*; 127. *S. virgatum s.l.*; 128. *S. gonzalezi*; 129. *S. ganalesense* (Belize form); 130. *S. callidum*.

131

132

133

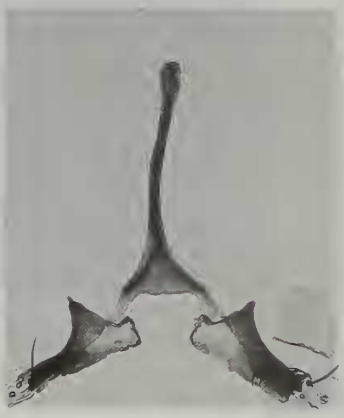
134

135

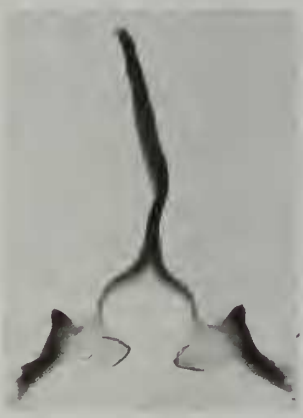
136

Figs 131–136. Cercus and paraproct of: 131. *S. haematopotum*; 132. *S. ochraceum s.l.*; 133. *S. quadrivittatum*; 134. *S. samboni*; 135. *S. metallicum s.l.*; 136. *S. racenisi*.

137



138



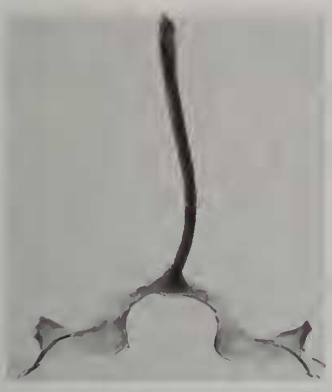
139

140

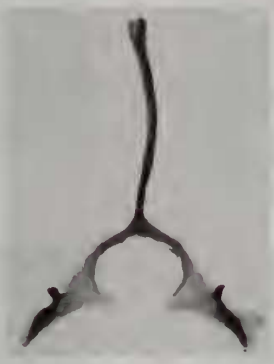
141

142

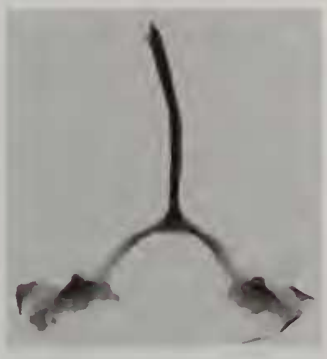
Figs 137–142. Genital fork of: 137. *S. earlei*; 138. *S. mexicanum*; 139. *S. pulverulentum*; 140. *S. virgatum s.l.*; 141. *S. gonzalezi*; 142. *S. ganalesense*.



143

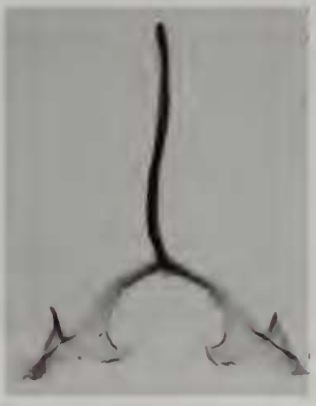


144



145

146



147

148

149

Figs 143–149. Genital fork of: 143. *S. callidum*; 144. *S. haematopotum*; 145. *S. ochraceum s.l.*; 146. *S. quadrivittatum*; 147. *S. samboni*; 148. *S. metallicum s.l.*; 149. *S. jobbinsi*.

150

151

152

153

154

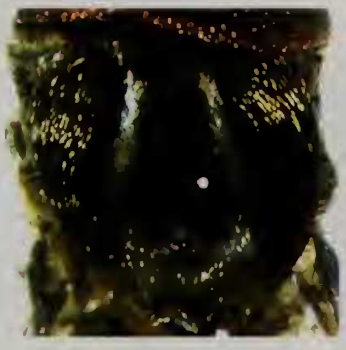
155

Figs 150–155. Colour patterns of the male thorax of: 150. *S. earlei*, anterior illumination; 151. *S. earlei*, posterior illumination; 152. *S. mexicanum,* anterior illumination; 153. *S. mexicanum,* posterior illumination; 154. *S. pulverulentum*, anterior illumination; 155. *S. pulverulentum*, posterior illumination;

156

157

158



159

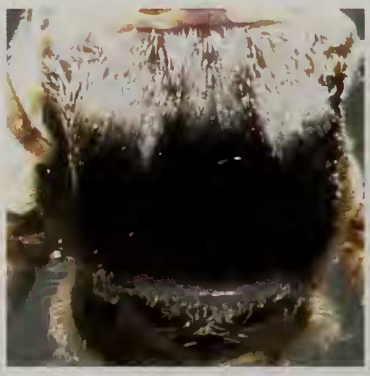
160

161

Figs 156–161. Colour patterns of the male thorax of: 156. *S. virgatum s.l.*, anterior illumination; 157. *S. virgatum s.l.*, posterior illumination; 158. *S. virgatum s.l.* (black form), anterior illumination; 159. *S. virgatum s.l.* (black form), posterior illumination; 160. *S. virgatum s.l.* (holotype), anterior illumination; 161. *S. virgatum s.l.* (holotype), posterior illumination.

162

163



164

165

166

167

Figs 162–167. Colour patterns of the male thorax of: 162. *S. rubrithorax* (Brazil), anterior illumination; 163. *S. rubrithorax* (Brazil), posterior illumination; 164. *S. paynei* (Ecuador), anterior illumination; 165. *S. paynei* (Ecuador), posterior illumination; 166. *S. paynei* (as *S. acatenangoense*, Guatemala), anterior illumination; 167. *S. paynei* (as *S. acatenangoense*, Guatemala), posterior illumination.

168

169

170

171

172

173

Figs 168–173. Colour patterns of the male thorax of: 168. *S. paynei* (as *S. mathesoni*, Mexico), anterior illumination; 169. *S.* paynei (as *S. mathesoni*, Mexico), posterior illumination; 170. *S. gonzalezi*, anterior illumination; 171. *S. gonzalezi*, posterior illumination; 172. *S. ganalesense* (Belize form), anterior illumination; 173. *S. ganalesense* (Belize form), posterior illumination.

174

175

176

177

178

179

Figs 174–179. Colour patterns of the male thorax of: 174. *S. ganalesense* (holotype), anterior illumination; 175. *S. ganalesense* (holotype), posterior illumination; 176. *S. callidum*, anterior illumination; 177. *S. callidum*, posterior illumination; 178. *S. haematopotum*, anterior illumination; 179. *S. haematopotum*, posterior illumination.

180

181

182

183

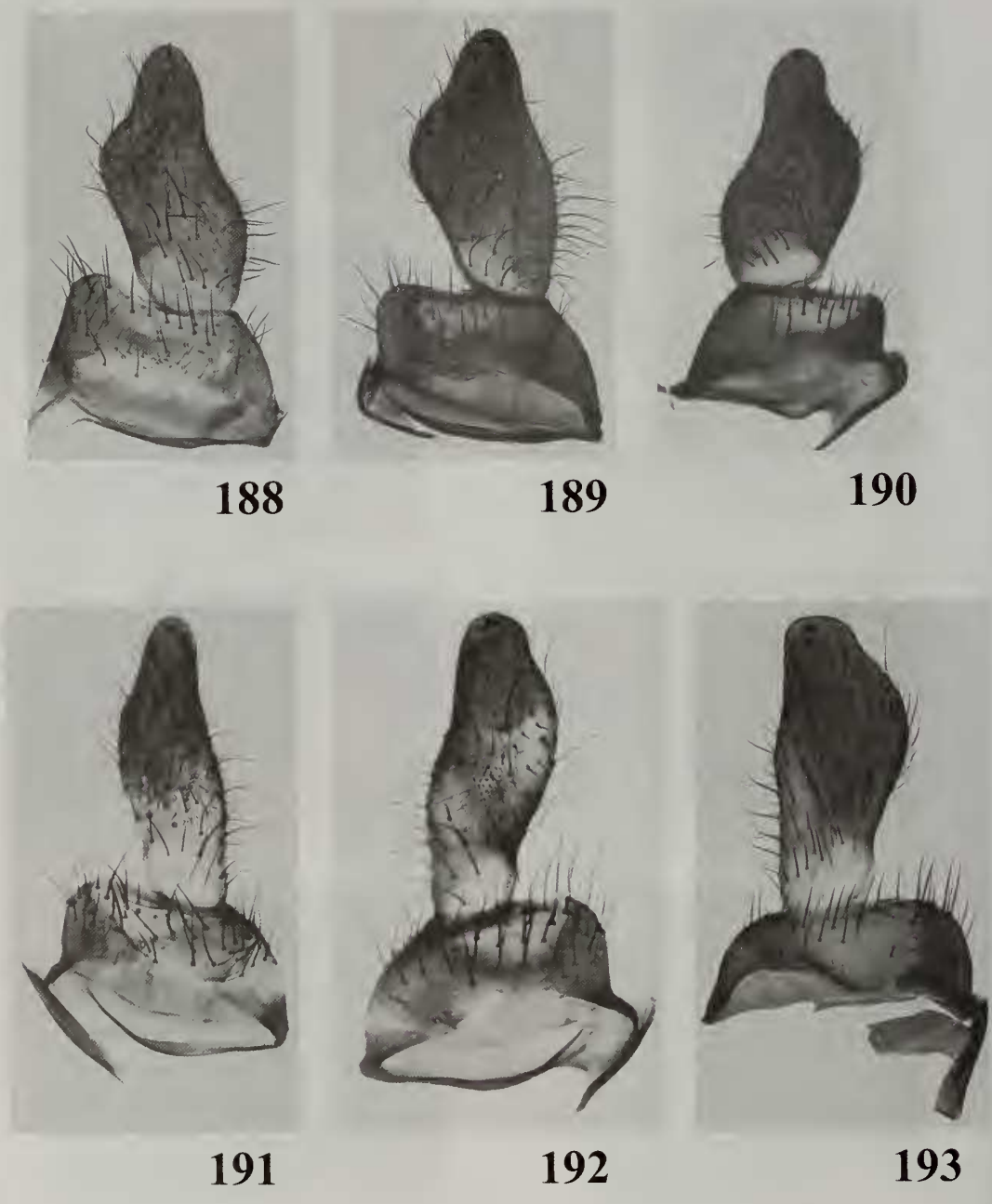
184

185

186

187

Figs 180–187. Colour patterns of the male thorax of: 180. *S. ochraceum s.l.*, anterior illumination; 181. *S. ochraceum s.l.*, posterior illumination; 182. *S. quadrivittatum,* anterior illumination; 183. *S. quadrivittatum,* posterior illumination; 184. *S. samboni*, anterior illumination; 185. *S. samboni*, posterior illumination; 186. *S. metallicum s.l.*, anterior illumination; 187. *S. metallicum s.l.,* posterior illumination.



Figs 188–193. Gonocoxite and gonostyle of: 188. *S. earlei*; 189. *S. mexicanum*; 190. *S. pulverulentum*; 191. *S. virgatum s.l.*; 192. *S. virgatum s.l.* (black form); 193. *S. virgatum* (holotype) – left hand side.

194

195

196

197

198

199

Figs 194–199. Gonocoxite and gonostyle of: 194. *S. virgatum* (holotype) – right hand side; 195. *S. paynei* (Ecuador) with one spine; 196. *S. paynei* (Ecuador) with two spines; 197. *S. paynei* (as *S. mathesoni*, Mexico); 198. *S. rubrithorax* (Brazil); 199. *S. gonzalezi* (holoptic form).

200

201

202

203

204

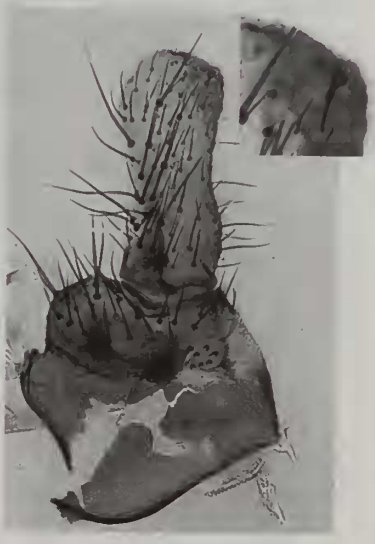
Figs 200–204. Gonocoxite and gonostyle of: 200. *S. ganalesense* (Belize form); 201. *S. ganalesense* (holotype); 202. *S. callidum*; 203. *S. haematopotum*; 204. *S. ochraceum s.l.*

205

206

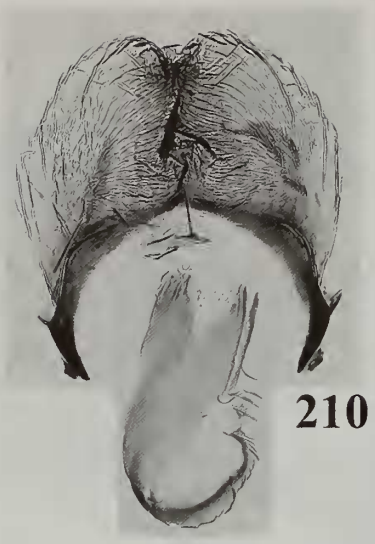
207

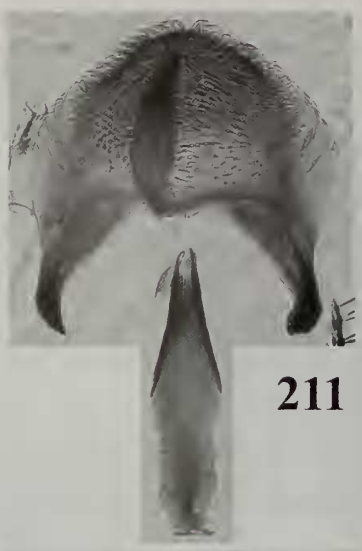
208



209

Figs 205–209. Gonocoxite and gonostyle of: 205. *S. quadrivittatum*; 206. *S. samboni*; 207. *S. metallicum s.l.*; 208. *S. jobbinsi* (holotype); 209. *S. racenisi.*





Figs 210–215. Ventral view of ventral plate and median sclerites of: 210. *S. earlei*; 211. *S. mexicanum*; 212. *S. pulverulentum*; 213. *S. virgatum s.l.*; 214. *S. virgatum s.l.* (black form); 215. *S. virgatum* (holotype).

216

217

218

219

220

Figs 216–220. Ventral view of ventral plate and median sclerites of: 216. *S. paynei* (Ecuador); 217. *S. paynei* (as *S. mathesoni*, Mexico); 218. *S. rubrithorax* (Brazil); 219. *S. gonzalezi* (holoptic form); 220. *S. gonzalezi* (dichoptic form).

221

222

223

224

225

Figs 221–225. Ventral view of ventral plate and median sclerites of: 221. *S. ganalesense* (Belize form); 222. *S. ganalesense* (paratype); 223. *S. callidum*; 224. *S. haematopotum*; 225. *S. ochraceum s.l.*

226

227

228

229

230

Figs 226–230. Ventral view of ventral plate and median sclerites of: 226. *S. quadrivittatum*; 227. *S. samboni*; 228. *S. metallicum s.l.*; 229. *S. jobbinsi* (holotype); 230. *S. racenisi*.

231

232

233

234

235

236

237

Figs 231–237. Paramere of: 231. *S. earlei*; 232. *S. mexicanum*; 233. *S. pulverulentum*; 234. *S. virgatum s.l.*; 235. *S. virgatum s.l.* (black form); 236. *S. virgatum* (holotype); 237. *S. paynei* (Ecuador).

238

239

240

241

242

243

Figs 238–243. Paramere of: 238. *S. paynei* (as *S. mathesoni*, Mexico); 239. *S. rubrithorax* (Brazil); 240. *S. gonzalezi* (holoptic form); 241. *S. ganalesense* (Belize form); 242. *S. ganalesense* (holotype); 243. *S. callidum*.

244

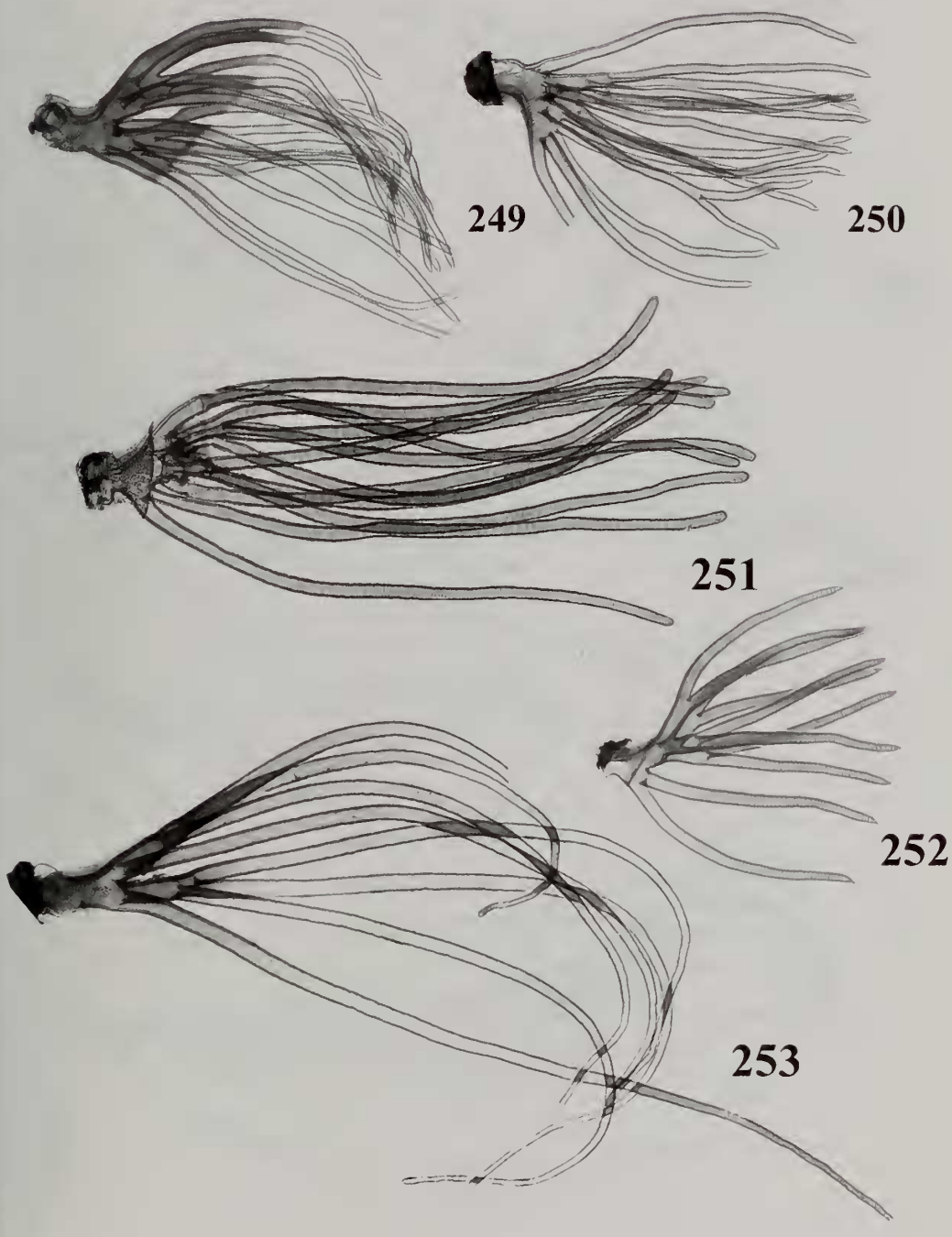
245

246

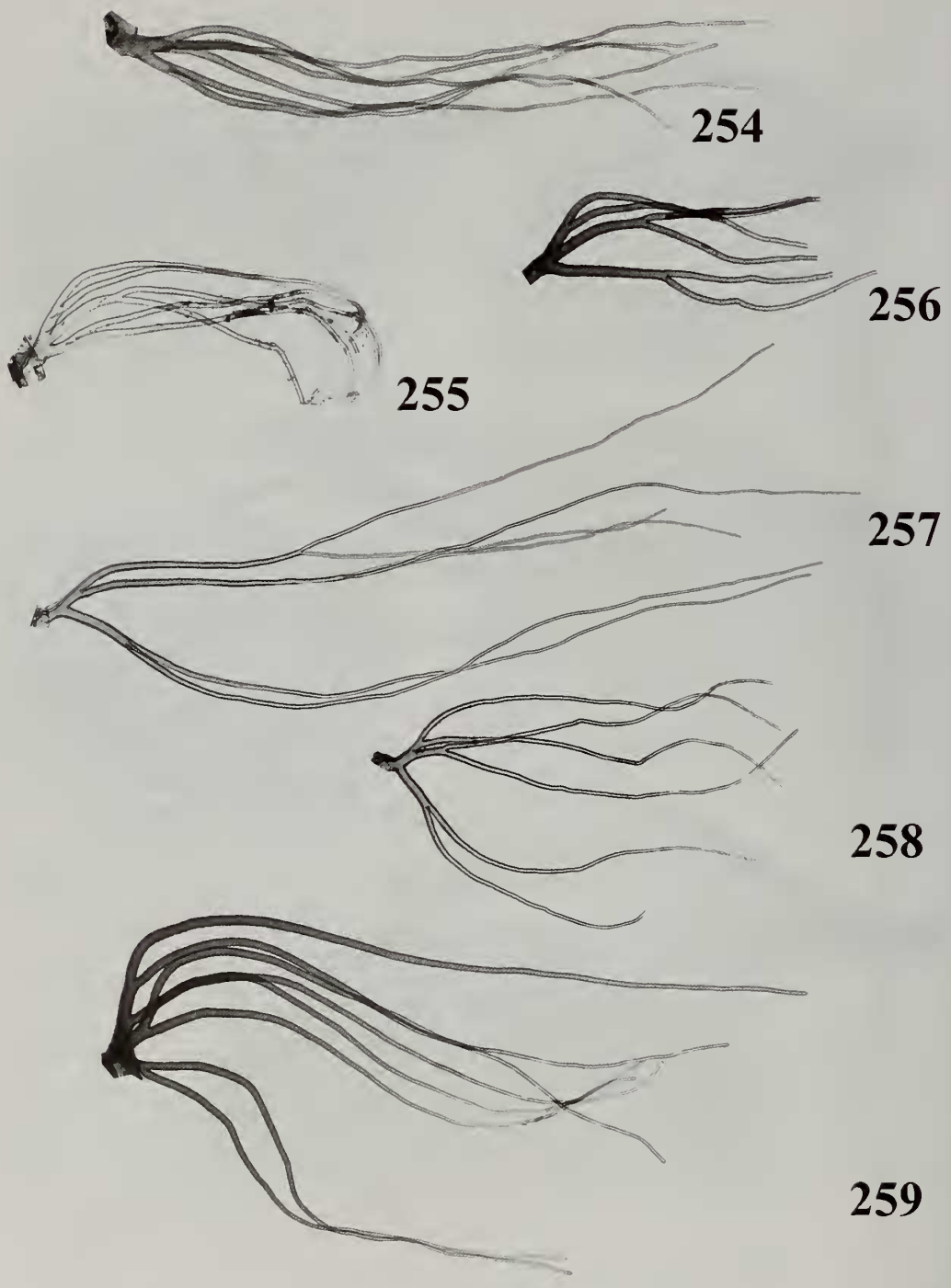
247

248

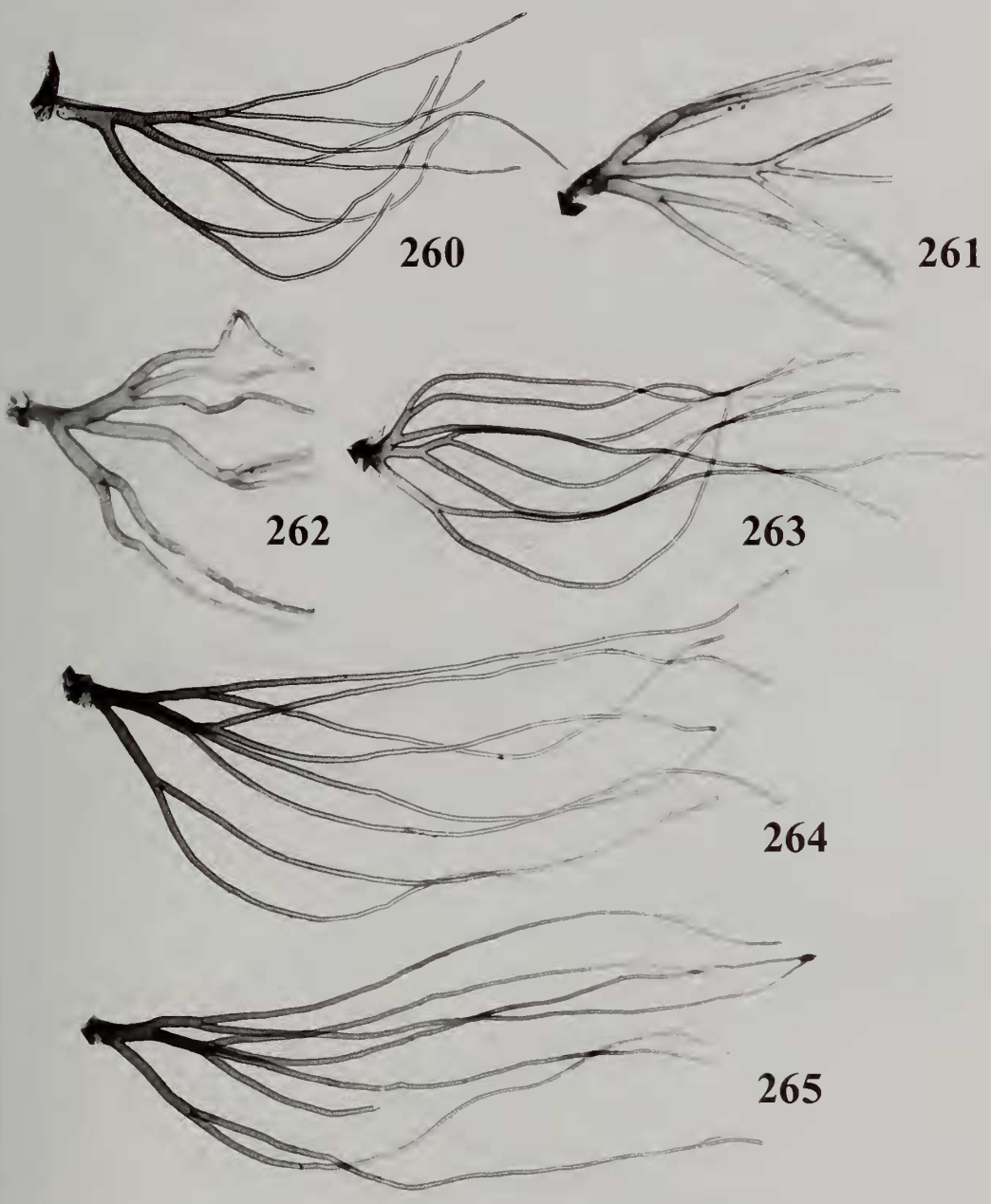
Figs 244–248. Paramere of: 244. *S. haematopotum*; 245. *S. ochraceum s.l.*; 246. *quadrivittatum*; 247. *S. samboni*; 248. *S. metallicum s.l.*



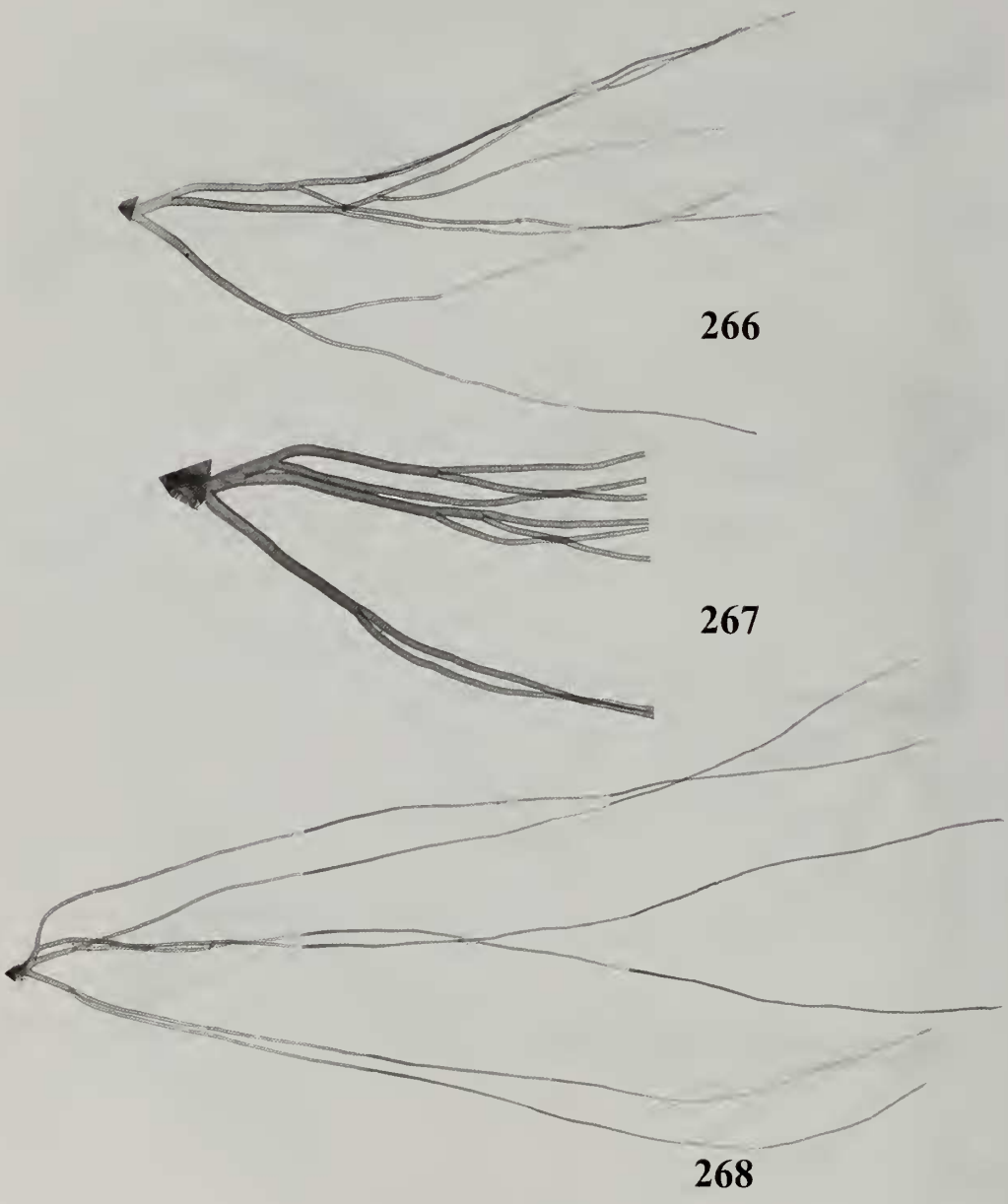
Figs 249–253. Pupal gill of: 249. *S. earlei* (typical form); 250. *S. earlei* (atypical form); 251. *S. mexicanum*; 252. *S. pulverulentum*; 253. *S. virgatum s.l.*



Figs 254–259. Pupal gill of: *S. gonzalezi* (Belize specimen); 255. *S. gonzalezi* (Guatemala specimen); 256. *S. gonzalezi* (Ecuador specimen); 257. *S. ganalesense* (Belize form); 258. *S. ganalesense* (paratype, Mexico); 259. *S. callidum.*



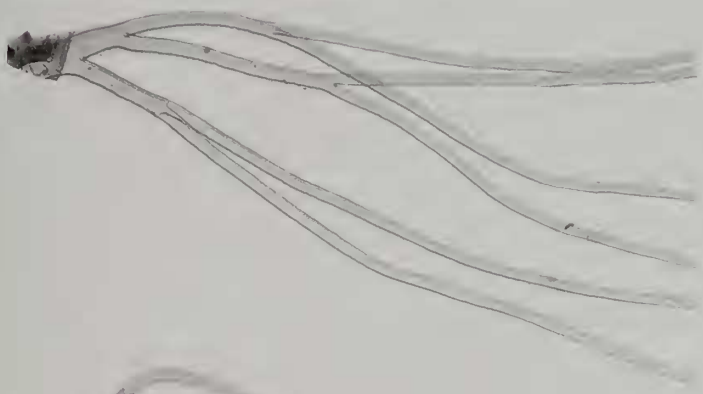
Figs 260–265. Pupal gill of: *S. haematopotum* (typical form); 261. *S. haematopotum* (atypical form); 262. *S. haematopotum* (atypical form); 263. *S. ochraceum s.l.*; 264. *S. quadrivittatum* (typical form); 265. *S. quadrivittatum* (atypical form);



Figs 266–268. Pupal gill of: 266. *S. samboni* (typical form); 267. *S. samboni* (atypical form); 268. *S. metallicum s.l.* (typical form).

269

270



271

272

Figs 269–272. Pupal gill of: 269. *S. metallicum s.l.* (atypical form); 270. *S. jobbinsi*; 271. *S. racenisi;* 272. *S. horacioi.*

Table 1. Distribution of Simuliidae in Belize.

Districts	Localities	*call*	*earl*	*gan*	*gonz*	*haem*	*met*	*mex*	*ochr*	*pulv*	*quad*	*samb*	*virg*
Cayo (Mountain Pine Ridge area)	Augustine (Douglas Da Silva)		X							X	X	X	X
	Rio Frio										X	X	
	small stream	X					X				X		
	Rio Frio Caves	X					X	X				X	X
	Mahogany Creek	X					X	X				X	
	small stream nr. Mahogany Creek										X		
	R. Macal at: Guacamallo		X		X	X	X			X			
	: Bailarina Camp				X	X	X			X		X	
	: small stream before Bailarina Creek						X	X	X		X		
	: Chalillo (proposed dam)				X		X			X	X		
	Little Vaqueros Creek	X					X						
	Little Vaqueros Creek tributuary	X					X	X			X		
	Oak Burn	X						X		X			
	Paddy Creek	X					X	X			X	X	
	Privación Creek	X				X	X				X	X	X
	Privación Creek at Blancaneaux Lodge (dam)	X					X				X		
	: small stream into Privación Creek	X					X						
	1000 ft. Falls, Hidden Valley						X				X		
	Rio On	X	X		X		X			X	X	X	X
	Rio Pinol	X	X				X						X
	San Luis	X					X						
Cayo (Chiquibul Forest area)	Las Cuevas Research Station						X				X		
	Grano de Oro					X	X				X		
	R. Chiquibul, Natural Arch	X	X		X		X	X					
	Logging Camp											X	
	Zaden Creek (Millonario)	X					X				X		X
	Monkey Trail Branch	X					X					X	
	Smoky River											X	
Cayo (San Ignacio area)	North/South Western Highway at:												
	Billy White Creek					X							
	: Cadena Creek					X							
	: Garbutt' s Falls									X			
	: Soccoths									X			
	: Garbutt's Creek									X			
	: Cool Shade	X											
	: Central Farm					X				X			
	: San Antonio						X				X		
	: small stream after Belmopan									X			
Stann Creek	Hummingbird Highway at:												
	Caves Branch						X			X		X	
	: R. Sibun		X				X			X			
	: Fairweather Creek	X										X	

Table 1 continued

Districts	Localities	*call*	*earl*	*gan*	*gonz*	*haem*	*met*	*mex*	*ochr*	*pulv*	*quad*	*samb*	*virg*
	: Dry Creek	X										X	
	Hummigbird Highway at:												
	Hell's Teeth	X						X			X	X	X
	: Middlesex					X	X					X	
	: North Branch						X					X	
	: near Pomona (Ritchie's Farm)					X							
	Southern Highway at: small stream												
	after Little Dry Creek			X		X							
	: first creek after Santa Rosa Creek			X	X	X							
	: South Stann Creek				X	X							
	: small stream (un-named)					X					X	X	
	: Sittee River			X		X				X			
	: Silk Grass Creek											X	
	: Mayflower Creek				X	X	X				X	X	
	Hummingbird Highway at: North												
	Stann Creek (Forest Dept.)			X		X							
	: North Stann Creek (S. Middlesex)			X	X		X						
Belize	Coastal Highway at: un-named creek											X	
	: Soldier Creek				X			X					
	: Mahogany Creek					X					X		
Toledo	Manfredi Creek					X					X	X	
	Blue Creek											X	
	Aguacate Creek				X	X				X		X	
	Go to Hell Creek										X	X	
	Corazón Creek											X	
	first creek after Corazón Creek											X	
	R. Temash									X		X	
	R. Blanco (waterfalls)									X			
	Jalacte Creek											X	
	Black Creek						X			X	X	X	
	Southern Highway at: Rio Grande												
	Big Falls				X					X			
	: Punta Gorda (Salamanca)						X						
	: small stream (un-named)						X						
	: Golden Stream												
	: Medina Bank Creek											X	
	: small stream (un-named)												
	: Bladen Branch			X									
	R. Swasey at: Cowpen					X							
	: under Bridge			X	X							X	
	: upper river	X		X		X							
	small stream (un-named)					X							

Species abbreviations: *call*, *S. callidum*; *earl*, *S. earlei*; *gan*, *S. ganalesense*; *gonz*, *S. gonzalezi*; *haem*, *S. haematopotum*; *quad*, *S. quadrivittatum*; *mex*, *S. mexicanum*; *met*, *S. metallicum s.l.*; *ochr*, *S. ochraceum s.l.*; *pulv*, *S. pulverulentum*; *samb*, *S. samboni*; *virg*, *S. virgatum s.l.*

Table 2. Colour variation in female of *S. virgatum s.l., S. paynei, S. rubrithorax* (in bold and italics) and their synonyms (in italics).

Species	Female			
	Scutum	Scutellum	Postnotum	Pleura
S. virgatum s.l.				
Guatemala	orange-brown	orange-grey	orange	orange-grey
Mexico	orange-brown	orange-grey	orange	orange-grey
Panama	mid brown	orange-grey	orange	orange-grey
Belize, brown form	brown	dark brown to black	dark brown to black	grey-black
S. rubicundulum				
Holotype, paratype	brown	brown-black	brown-black	brown-black
S. paynei				
Ecuador	dark brown	dark brown	black	brown-black
Venezuela	orange-brown	orange-brown	light brown	light brown
S. acatenangoense	orange-brown	dark brown	dark brown	brown-grey
S. mathesoni	orange-brown	orange	black	brown-grey
S. rubrithorax	orange-brown to dark brown	dark brown	dark brown or black	brown-grey

Table 3. Colour variation in male of *S. virgatum s.l., S. paynei, S. rubrithorax* (in bold and italics) and their synonyms (in italics).

Species	Female			
	Scutum	Scutellum	Postnotum	Pleura
S. virgatum s.l.				
Holotype	dark brown-black	dark brown	dark brown	black
Guatemala	orange to light brown	orange to light brown	orange to light brown	orange to light brown
Mexico	mid to dark brown	mid to dark brown	black	brown-grey
Panama	orange to light brown	orange to light brown	orange to light brown	orange to light brown
Belize, brown form	orange to dark brown	dark brown to black	dark brown to black	orange-black
Belize, black form	black	dark brown	black	greyish-black
S. paynei				
Ecuador	dark brown to black	dark brown to black	dark brown to black	greyish-brown
Venezuela	dark brown	dark brown	dark brown	dark brown
S. acatenangoense	dark brown to black	dark brown to black	dark brown to black	greyish-brown
S. mathesoni	dark brown to black	dark brown to black	dark brown to black	
S. rubrithorax	chestnut brown	dark brown	dark brown	brownish-grey

Table 4. Comparative morphology of *S. metallicum* and closely related species.

Characters	*S. metallicum*	*S. jobbinsi*	*S. racenisi*	*S. horacioi*
FEMALE				
Genital fork				
arched	narrowly	broadly	narrowly	?
anterior processes	well developed	absent	absent	?
Paraproct/cercus ratio	5:3	5:3	6:4	?
Sternite VII plate	usually absent	present	present	present
MALE				
Gonostyle distal margin	pointed	rounded	rounded	rounded
Ventral plate				
keel	well developed	reduced	reduced	reduced
basal arms	broad	thin	broad	broad
Endoparameral organ well developed teeth	4	2	4	?
PUPA				
6th sternite spines	present	?	absent	absent
Dorsal gill filament	curved	curved	straight	curved

? character not examined.

MATERIAL EXAMINED

All material collected in 2001 in Belize by A.J.Shelley & L.M.Hernández has been deposited in the BMNH under accession number B.M. 2001–168. The collector name L.M.Hdez is an abbreviation for L.M.Hernández. Elsewhere, A.J.S. is an abbreviation for A.J.Shelley.

Simulium (*Hemicnetha*) *earlei* Vargas, Martínez Palacios & Díaz Nájera

TYPE MATERIAL
MEXICO
Morelos State

SLIDE
Temixco; 3.vii.1945, (*A.Díaz N.*) – ♂ [HOLOTYPE No. 3844], 1♀ [PARATYPE, as ALLOTYPE No 3845] (INDRE).

PINNED
Temixco; 5.vii.1945, (*A.Díaz Nájera*) – 1♂ [PARATYPE] (INDRE).

OTHER MATERIAL
BELIZE
Cayo District

PINNED
Rio Pinol, (Nos. 17, 18); 31.i.1958, (*P.C.C.Garnham & D.J.Lewis*) – 2♀♀ (BMNH). Privación Creek; 31.i.1958, (*P.C.C.Garnham & D.J.Lewis*) – 1♂ (BMNH). Mountain Pine Ridge, Rio On, (site B15), 16°59'N88°58'W, 1536 ft.; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀1♂ (reared) (BMNH).

SLIDE
Mountain Pine Ridge, Guacamallo Bridge, R. Macal, (site B1), 16°51'N89°02'W, 1209 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 pupa (BMNH). Chiquibul Forest area, Natural Arch, nr. Arabato Camp, R. Chiquibul, (site B6), 16°37'N89°02'W, 1798 ft.; 9.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀1♂ (reared), 1 pupa (BMNH). Guacamallo Bridge, (BE96–25); 15.iv.1996, (*R.Lane*) – 2 pupae (BMNH).

SPIRIT
Mountain Pine Ridge, Guacamallo Bridge, R. Macal, (site B1), 16°51'N89°02'W, 1209 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2 pupae (BMNH). Guacamallo Bridge; 15.iv.1996, (*R. Lane*) – 2 pupae (BMNH). Chiquibul Forest area, Natural Arch, nr. Arabato Camp, R. Chiquibul, (site B6), 16°37'N89°02'W, 1798 ft.; 9.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2 pupae (BMNH).

There is a total of 7 slides collected, prepared and identified by *D.J.Lewis* as *S. earlei*. Some slides contain more than one specimen and many of the specimens could not be identified without remounting. Slides where Lewis' s identification has been confirmed are marked with the stage of the specimen(s) and L.M.Hernández: Rio Pinol, (Nos. 13, 17, 18); 31.i.1958, (*P.C.C.Garnham & D.J.Lewis*). R. Siburn; 6.ii.1958, (*P.C.C.Garnham & D.J.Lewis*). Privación Creek; 31.i.1958, (*D.J.Lewis*). Privación Creek; 31.i.1958, (*P.C.C.Garnham & D.J.Lewis*). Augustine, (No.1209); 27.vii.1961, (*D.J.Lewis*) (all BMNH).

GUATEMALA
Escuintla Department

PINNED
Pasa de Padre, Las Ilusiones, Santa Lucia, Cutz., (No. 3v–55); 30.xi.1948, (*H.T.Dalmat*) – 1♂ (BMNH).

Santa Rosa Department

PINNED
Zacuapa, km 10 y 20, F.S.Jacinto, Santa Rosa, (No. 3w-1); 30.xi.1948, (*H.T.Dalmat*) – ♀ (BMNH).

MEXICO
Guerrero State

PINNED
Cocula; 24.iii.1936, (*R.Ruiz Soto*) – 1♂ (INDRE, 6346).

Morelos State

SLIDE
Temixco; 3.vii.1945, (*A.Díaz N.*) – 1♀ (only gill filaments), 1♂ (only genitalia) (BMNH).

SPIRIT
Temixco; 3.vii.1945, (*A.Díaz N.*) – 8 pupae (BMNH – Ex. London School of Hygiene & Tropical Medicine) (BMNH. B.M.1948–401).

Veracruz State

PINNED
Córdoba: Rio San Antonio; 13.ix.1945, (*J.Parra S.*) – 1♀(INDRE).

Simulium (*Hemicnetha*) *mexicanum* Bellardi

BELIZE
Belize District

SPIRIT
Placencia-Dandriga-La Democracia rd. (Coastal Highway), Soldier Creek, (site B59), 17°10'N88°23'W, 141 ft.; 26.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 pupa (BMNH).

Cayo District

PINNED
Mountain Pine Ridge, small stream (un-named) before Bailarina Camp, (site B8), 16°51'N88°59'W, 1376 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (reared) (BMNH). Mountain Pine Ridge, Mahogany Creek, (site B12), 16°55'N89°00'W; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀2♂♂ (reared) (BMNH). Mountain Pine Ridge, Paddy Creek, (site B14), 16°56'N89°00'W, 1455 ft.; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 3♀♀ (reared) (BMNH).

SLIDE
Chiquibul Forest area, Natural Arch, R. Chiquibul, nr. Arabato

Camp, (site B6), 16°37'N89°02'W, 1798 ft.; 9.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♀ (reared) (BMNH). Mountain Pine Ridge, small stream (un-named) before Bailarina Camp, (site B8), 16°51'N88°59'W, 1376 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♂ (reared) (BMNH). Mountain Pine Ridge, R. Frio Cave, (site B10), 16°59'N88°00'W, 1430 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♀ (reared) (BMNH). Mountain Pine Ridge,. Mahogany Creek (site B12), 16°55'N89°00'W; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♂ (reared) (BMNH). Mountain Pine Ridge, Paddy Creek, (site B14), 16°56'N89°00'W, 1455 ft.; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♀ (reared) (BMNH).

Stann Creek District

PINNED
Hells Teeth; 15.ii.1958, (*P.C.C.Garnham & D.J.Lewis*) – 3 ♀♀ 3 ♂♂ (BMNH).

There is a total of 12 slides collected, prepared and indentified by D.J.Lewis as *S. mexicanum*. Many of the slides contain more than one specimen and many of the specimens could not be identified without remounting. Slides where Lewis' s identification has been confirmed are marked with the stage of the specimen(s) and L.M.Hernández.The following localities are registered where the identifications have been confirmed: **Cayo District**: Oak Burns; 31.i.1958, (*D.J.Lewis*) (BMNH). **Stann Creek District**: Hell's Teeth; 10.ii., 15.ii.1958, (*P.C.C.Garnham & D.J.Lewis*) (BMNH).

COLOMBIA

PINNED
Norte de Santander, Arboledas, Siravita, La Esperanza; 26.vii.1986, (*B.Alexander*) – 3 ♀♀ (BMNH).

ECUADOR
Carchi Province

PINNED
Chical; 18.vi.1983, (*J.Rawlins*) – 2 ♀♀ 5 ♂♂ (BMNH).

Esmeraldas Province

PINNED
Santo Domingo-Esmeraldas road, Rio Achioti; 26.ix.1983, (*A.J.Shelley & M.Arzube*) – 6 ♀♀ 10 ♂♂ (reared) (BMNH). San Miguel de Cayapas, Casacadita, R.Cayapa; 17.vi., 26.v.1981, (*A.J.Shelley & M.Arzube*) – 3 ♀♀ 5 ♂♂ (reared) (BMNH).

SLIDE
Agua Blanca, R. Cayapa; 15.vii.1986, (*P. Beech*) – 1 ♀ (reared) (BMNH). San Miguel de Cayapas, Casacadita, R.Cayapa; 7.vi. & 26.v.1981, (*A.J.Shelley & M.Arzube*) – 2 ♀♀ 2 ♂♂ (reared) (BMNH).

SPIRIT
Santo Domingo-Esmeraldas road, R.Tabuchi; 26.ix.1983, (*A.J.Shelley & M.Arzube*) – numerous pupae and larvae (BMNH).

Imbabura Province

PINNED
Stream at 40 km from Ibarra on Salinas-Lita road; 11.ix.1983 (*A.J.Shelley & M.Arzube*) – 4 ♀♀ 2 ♂♂ (reared) (BMNH).

SLIDE
Salinas-Lita road, 54 km from Ibarra, Rio San Pedro; 11.ix.1983, (*A.J.Shelley & M.Arzube*) – 1 ♂ (reared) (BMNH).

SPIRIT
Stream at 40 km from Ibarra on Salinas-Lita road; 11.ix.1983, (*A.J.Shelley & M.Arzube*) (BMNH) – numerous pupae (BMNH). Stream at 40 km from Ibarra on Salinas-Lita road, San Pedro; 11.ix.1983, (*A.J. Shelley & M.Arzube*) – 3 ♀♀ 2 ♂♂ (reared) (BMNH). Quito-Santo Domingo road, R. Toachi; 28.ix.1983, (*A.J. Shelley & M.Arzube*) – numerous pupae (BMNH).

MEXICO
Chiapas State

PINNED
Escuintla, Jalapa Aldeia; xi.1935, (no collector) – 2 ♀♀ (BMNH).

Veracruz State

SPIRIT
B. Sn. Miguel; 14.ix.1945, (*J.Parra*) – 2 ♀♀ 2 ♂♂, 4 pupae (BMNH-Ex. London School of Tropical Medicine).

PANAMA
Coclé Province

SPIRIT
El Valle; 17.iii.1940, (*R.P.*) – 1 pupa, 4 cocoons (BMNH).

VENEZUELA
Trujillo State

SLIDE
La Puerta; 21.v.1961, (*D.J.Lewis*) – several pupae and adults on same slide (BMNH).

Simulium (*Hemicnetha*) *pulverulentum* Knab

TYPE MATERIAL

BELIZE
Stann Creek District

PINNED
Br. Honduras; Punta Gorda, [no collection date], (*J.D.Norton*) – 2 ♀♀ [PARATYPES] [as Cotype No. 1911] (BMNH, B.M.1952–404, presented by USNM).

OTHER MATERIAL

BELIZE
Cayo District

PINNED
Soccoths; 11.ii.1958, (*P.C.C.Garnham & D.J.Lewis*) – 1 ♀ 1 ♂ (BMNH). Sibun; 6.ii.1958, (*P.C.C.Garnham & D.J.Lewis*) – 1 ♀ (BMNH). Rio On; 5.ii.1958, (*P.C.C.Garnham & D.J.Lewis*) – 1 ♂ (BMNH). Central Farm, (ID1682); 6.x.1975, (*R. Arkers*) – 1 ♀ (on *Zea mays*) (BMNH). Mountain Pine Ridge, San Ignacio-Las Cuevas Rd, before Guacamallo Bridge,

Bailarina Camp, (site B7), 16°51'N88°59'W, 1294 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (reared) (BMNH). Mountain Pine Ridge, Rio On, (site B15), 16°59'N88°58'W, 1536 ft.; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2♀♀4♂♂ (reared) (BMNH). Western Highway to Belmopan-San Ignacio area, small stream (un-named) after Belmopan, (site B23), 17°16'N88°46'W, 217 ft.; 15.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀2♂♂ (reared) (BMNH).

SLIDE

Central Farm, (ID 1682); 6.x.1975, (*R.Arkers*) – 1♀ (only genitalia) (on *Zea mays*) (BMNH). Mountain Pine Ridge, San Ignacio-Las Cuevas Rd, before Guacamallo Bridge, Bailarina Camp, (site B7), 16°51'N88°59'W, 1294 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (reared) (BMNH). Western Highway to Belmopan-San Ignacio area, small stream (un-named) after Belmopan, (site B23), 17°16'N88°46'W, 217 ft.; 15.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (reared) (BMNH).

SPIRIT

Mountain Pine Ridge, Guacamallo Bridge, R. Macal, (site B1), 16°51'N 89°02'W, 1209 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (reared), 16 pupae, 4 cocoons (BMNH). Mountain Pine Ridge, San Ignacio-Las Cuevas Rd, before Guacamallo Bridge, Bailarina Camp, (site B7), 16°51'N88°59'W, 1294 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 5♂♂ (reared) (BMNH). Mountain Pine Ridge, Chalillo (proposed dam), R. Macal, (site B9), 16°51'N88°00'W, 1286 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 3♂♂ (reared) (BMNH). Mountain Pine Ridge, Rio On, (site B15), 16°59'N88°58'W, 1536 ft.; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 pupa (BMNH). Western Highway to Belmopan San Ignacio area, small stream (un-named) after Belmopan, (site B23), 17°16'N88°46'W, 217 ft.; 15.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀2♂♂ (reared), 2 pupae (BMNH). Augustine; 1.vii.1968, (*W.L.Hazse*) – 1♀2♂♂ (at black light) (USNM).

Stann Creek District

PINNED

Placencia-Middlesex rd. (Southern Highway), Sittee River, (site B53), 16°49'N88°23'W, 148 ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (reared) (BMNH).

Toledo District

PINNED

Blue Creek-Santa Theresa rd., Aguacate Creek, (site B27), 16°08'N89°00'W, 140 ft.; 18.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 4♂♂ (reared) (BMNH). Otoxha Village, R. Temash, (site B31), 16°00'N 89°11'W, 200 ft.; 18.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (reared) (BMNH). Rio Blanco (waterfalls), (site B32), 16°13'N89°05'W, 430 ft.; 19.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2♀♀ (reared) (BMNH). Southern Highway, Big Falls, Rio Grande, (site B35), 16°15'N88°53'W, 117 ft.; 20.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2♀♀ (reared) (BMNH). San Pablo, Southern Highway, R. Swasey, (site B49), 16°34'N88°32'W, 268 ft.; 24.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (reared) (BMNH).

SLIDE

Blue Creek-Santa Theresa rd., Aguacate Creek, (site B27), 16°08'N89°00'W, 140 ft.; 18.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (reared) (BMNH). Rio Blanco (waterfalls), (site B32), 16°13'N89°05'W, 430 ft.; 19.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2♀♀4♂♂ (reared) (BMNH). Southern Highway, Big Falls, Rio Grande, (site B35), 16°15'N88°53'W, 117 ft.; 20.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (reared) (BMNH).

SPIRIT

Rio Blanco (waterfalls), (site B32), 16°13'N89°05'W, 430 ft.; 19.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 9♂♂ (reared), 1 pupa (BMNH).

There is a total of 20 slides collected, prepared and identified by D.J.Lewis as *S. pulverulentum*. Many of the slides contain more than one specimen and many of the specimen could not be identified without remounting. Slides where Lewis's identification has been confirmed are marked with the stage of the specimen(s) and A.J.S. The following localities are registered where the identifications have been confirmed. **Cayo District**: Soccoth; 11.ii.1958, (*D.J.Lewis*), (*P.C.C.Garnham & D.J.Lewis*). Garbutt's Falls; 16.i.1958, (*P.C.C.Garnham & D.J.Lewis*). Garbutt's Falls Creek; 24.i.1958, (*P.C.C.Garnham & D.J.Lewis*). Guacamallo, 22.ix.1958, (*P.C.C.Garnham & D.J.Lewis*). Cave Branch, 20.i.1958, (*P.C.C.Garnham & D.J.Lewis*). Rio Pinol; 31.i.158, (*P.C.C.Garnham & D.J.Lewis*). Rio On; 5.ii.1958, (*P.C.C.Garnham & D.J.Lewis*). Oak Burn; 31.i.1958, (*P.C.C.Garnham & D.J.Lewis*).

GUATEMALA

Escuintla State

PINNED

Escuintla, R. Matapa, (No. 8G-5); 30.viii.1949, (*H.T.Dalmat*) – 2♀♀ (BMNH). R. Limón, (No. 12.0–4); 8.vi.1951, (*H.T.Dalmat*) – 1♂ (BMNH).

Quetzaltenango Department

PINNED

La Moka; 25.xi.1974, (*R.Garms*) – 3♀♀ (BMNH).

SPIRIT

La Moka; 27.iii.1974, (*R.Garms*) – 1♀ (BMNH).

HONDURAS

Cortés Department

SPIRIT

La Guama, 5m stream, 1.3 km from treatment pt.; 23.iii.1984, (*L.A.Lacey*) – numerous pupae (BMNH). La Guama treatment point; 23.iii.1984, (*L.A.Lacey*) – numerous pupae (BMNH). La Guama, 1.6 km from treatment point; 23.iii.1984, (*L.A.Lacey*) – numerous pupae (BMNH).

SLIDE

La Guama, 5m stream, 1.3 km from treatment pt.; 23.iii.1984, (*L.A.Lacey*) – 1♂ (reared), 1 pupa (BMNH).

MEXICO

Veracruz State

PINNED

Matacapan, Veracruz; x.1939, (*M.Macias*) – 2♀♀ (reared) (BMNH, B.M.1949–236).

SLIDE

Rio San Antonio, Cordona, Veracruz; 14.ix.1945, (*J.Parra*) – 1♀1♂ (only genitalia) (BMNH).

PANAMA

PINNED

Canal Zone, Junction of K6 and K9, Rio Cocoli, (site 6); 1–6.vi.1985, (*A.J.Shelley*) – 7♀♀5♂♂ (reared) (BMNH).

SPIRIT

Chorrera Falls, Chorrera; 31.iii.1940, (*R.P.*) – 4 pupae (BMNH-Ex. London School of Hygiene & Tropical Medicine). Canal Zone, nr. R. Gatuncillo, R. Limón, (site P9); 1–6.vii.1985, (*A.J.Shelley*) – 2 pupae (BMNH). Canal Zone, Junction of km 6 and km 9, Rio Cocoli, (site 6); 1–6.vi.1985, (*A.J.Shelley*) – 1♀4♂♂ (reared, 2 without pupa), numerous pupae (BMNH). Coclé Province, El Valle, Rio Antón, ½ km above bridge at San Carlos; 1–6.vii.1985, (*A.J.Shelley*) – 1♂ (reared), 9 pupae (BMNH).

VENEZUELA

PINNED

El Salto (Nos. 604–S, 277); 27.iv.1961, (*D.J.Lewis*) – 3♀♀ (BMNH). Rio Santa Maria, (No. 28); 7.v.1961, (*D.J.Lewis*) – 1♀ (BMNH). El Rincón, (No. 732–5); iv.1961, (*D.J.Lewis*) – 3♀♀ (BMNH). Cunanacora; 5.vi.1961, (*D.J.Lewis*) – 7♀♀ (BMNH). Monte Oscuro, (No. 818); 6.v.1961, (*D.J.Lewis*) – 1♀ (BMNH). San Juan Morron, Edo Guarico; (no collection date), (*Jaime Ramírez*) – 1♀ (reared) (BMNH).

Carabobo State

PINNED

Rio Tinaco, Aguadita; [no collection date or collector] – 1♂ (reared) (BMNH). La Aguadita, Rio Neveri, Anzoategui; [no collection date], (*Jaime Ramírez*) – 1♂ (reared) (BMNH).

SLIDE

La Aguadita, Rio Neveri, Anzoategui; [no collection date], (*Jaime Ramírez*) – 1♂ (reared) (pupa and genitalia) (BMNH).

There is a total of 5 slides collected, prepared and identified by D.J.Lewis as *S. pulverulentum*. Many of the slides contain more than one specimen and many of the specimen could not be identified without remounting. Slides where Lewis' s identification has been confirmed are marked with the stage of the specimen(s) and A.J.S. The following localities are registered where identifications have been confirmed: Rio Querecnal; 31.v.1961, (*D.J.Lewis*). El Salto, (No. 277); 26.iv.1961, (*D.J.Lewis*). Monte Oscuro, (No. 818); 6.v.1961, (*D.J.Lewis*). Los Altos; 7.iv.1961, (*D.J.Lewis*).

Simulium (*Hemicnetha*) *virgatum* Coquillett (complex)

TYPE MATERIAL

USA
New Mexico State

PINNED

Las Vegas, [Hot Springs]; 4.viii.[no year], (*H.S.Barber*) – 1♂ (less genitalia) [HOLOTYPE,Type no. 6183] (USNM).

SLIDE

Las Vegas, [Hot Springs]; 4.viii.[no year], (*H.S.Barber*) – 1♂ (genitalia) [HOLOTYPE, Type no. 6183] (USNM).

as ***S. rubicundulum* Knab**

MEXICO
Veracruz State

PINNED

Córdoba; 17.xii.1907, (*Fredk Knab*) – 1♀ (less abdomen and 1 hind leg) [HOLOTYPE, Type No. 19112] (USNM).

SLIDE

Córdoba; 17.xii.1907, (*Fredk Knab*) – 1♀ (abdomen and 1 hind leg) [HOLOTYPE, Type No. 19112] (USNM).

USA
New Mexico State

PINNED

Las Vegas, [Hot Springs]; 7.viii. [from Knab – 1914], (*H.S.Barber*) – 1♀ [PARATYPE, Type No. 19112] (USNM).

OTHER MATERIAL

BELIZE
Cayo District

PINNED

Mountain Pine Ridge, Privación Creek, (site B3), 17°00'N88°53'W, 2163 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (reared) (BMNH). Chiquibul Forest area, Zaden Creek (Millonario), (site B11), 16°53'N89°00'W; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (reared) (BMNH). Mountain Pine Ridge Rio On, (site B15), 16°59'N88°58'W, 1536 ft.; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 4♀♀5♂♂ (reared) (BMNH).

SLIDE

Mountain Pine Ridge, Rio On, (site B15), 16°59'N88°58'W, 1536 ft.; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 3♀♀2♂♂ (reared) (BMNH). Mountain Pine Ridge, Rio Pinol, (site B19), 17°00'N88°58'W, 1389 ft.; 13.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (reared) (BMNH).

SPIRIT

Augustine; 1.vii.1968, (*W.L.Hazse*) – 4♀♀ (at black light) (USNM). Mountain Pine Ridge, Rio On, (site B15), 16°59'N88°58'W, 1536 ft.; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2♂♂1♂ (reared), 1 pupa (BMNH).

Stann Creek District

PINNED

Hells Teeth; 15.ii.1958, (*P.C.C.Garnham & D.Lewis*) – 1♂ (BMNH).

There is a total of 8 slides collected, prepared and identified by D.J.Lewis as *S. virgatum*. Some slides contain more than one specimen and many of the specimens could not be identified without remounting. Slides where Lewis's identification has been confirmed are marked with the stage of the specimen(s) and A.J.S. The following localities are registered where identifications have been confirmed: **Cayo District**: Augustine, cave; 25.i.1958, (*P.C.C.Garnham & D.J.Lewis*). San Luis; 23.i.1958, (*P.C.C.Garnham & D.J.Lewis*). **Stann**

Creek District: Hell's Teeth; 15.ii.1959, (*P.C.C.Garnham & D.J.Lewis*).

CANADA
British Columbia State

PINNED
Horne Lake, Qualicum Bay; vi.1955, (*J.R.McGillis*) – 1♀ (BMNH). Qualicum Bay; 29.v.1955, (*R.Coyles*) – 1♂ (BMNH).

SLIDE
Horne Lake, Qualicum Bay; vi.1955, (*J.R.McGillis*) – 1♀ (BMNH). Qualicum Bay; 29.v.1955, (*R.Coyles*) – 1♂ (BMNH).

GUATEMALA
Chimaltenango Department

PINNED
Jaba, Montevideo, Yepocan (No. 778–4); 12.xi.1948, (*H.T.Dalmat*) – 1♀ (BMNH). Acatenango, Kikiya, Chalabal, (No. 638–16); 28.iv.1949, (*H.T.Dalmat*) – 1♀ (BMNH). Acatenango, Ladillera, F. Esperanza, (Nos. 680–33, 723–28); 2.vi.1949, (*H.T.Dalmat*) – 2♀♀ (BMNH). Acatenango, Pitinya, Santa Margarita, (No. 360–2); 22.x.1948, (*H.T.Dalmat*) – 1♀ (BMNH, B.M.1962–675). San Rafael Pacún, (Nos. 359–16, 359–23); 26.x.1948, (*H.T.Dalmat*) – 2♂♂ (BMNH, B.M.1962–675). Costita Providencia, Acatengango, (Nos. 354–1); 28.x.1948, (*H.T.Dalmat*) – 1♂ (BMNH, B.M.1962–675)

MEXICO
Chiapas State

PINNED
El Vergel; 15.iv.1944, (*Diaz N. Martínez*) – 2♀♀1♂ (BMNH, B.M.1949–276)

SLIDE
Finca El Vergel; 15.vi.1945, (*Diaz N. Martínez*) – 1♀ (only cibarium, genitalia and head) (BMNH)

SPIRIT
El Vergel; iii.1944, (*J.Parra*) – 5♀♀ (BMNH-Ex. London School of Hygiene & Tropical Medicine). El Vergel; 15.iv.1944, (*A.Diaz*) – 7 pupae (BMNH-Ex. London School of Hygiene & Tropical Medicine).

Morelos State

PINNED
Below Cuernavaca, Alameda Power Santation; i.1926, (*Major A.D.Fraser*) – 1♀ (BMNH, B.M.1926–81).

PANAMA
Chiriqui Province

SPIRIT
Los Planes de Hornito, 19 km from Gualaca, 8°38'N 82°14'W; 14.xii.1977, (*J.L.Petersen*) – 1♀1♂ (reared) (BMNH).

Coclé Province

PINNED
El Valle, Rio Antón, 560 m; 1–6.vii.1985, (*A.J.Shelley*) – 2♀♀8♂♂ (reared) (BMNH).

SPIRIT
El Valle, Rio Antón, (site P3), 560 m; 1–6.vii.1985, (*A.J.Shelley*) – 2♂♂ (reared), numerous pupae (BMNH).

Panama Province

SPIRIT
Canal Zone, Junction of km 6 and km 9, Rio Cocoli, (site P6); 1–6.vii.1985, (*A.J.Shelley*) – 5 pupae (BMNH).

Simulium (*Notolepria*) *gonzalezi* Vargas & Díaz Nájera

BELIZE
Belize District

PINNED
Placencia-Dandriga-La Democracia rd. (Coastal Highway), Soldier Creek, (site B59), 17°10'N88°23'W, 141 ft.; 26.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (reared) (BMNH).

SPIRIT
Placencia-Dandriga-La Democracia rd. (Coastal Highway), Soldier Creek, (site B59), 17°10'N88°23'W, 141 ft.; 26.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 4 pupae (BMNH).

Cayo District

PINNED
Chiquibul Forest area, nr. Arabato Camp, Natural Arch, R. Chiquibul, (site B6), 16°37'N89°02'W, 1798 ft.; 9.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2♀♀ (reared) (BMNH). Mountain Pine Ridge, San Ignacio-Las Cuevas Rd, before Guacamallo Bridge, Bailarina Camp, (site B7), 16°51'N88°59'W, 1294 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 12♀♀ (reared), 1♂ (holoptic), 4♂♂ (dichoptic) (reared) (BMNH). Mountain Pine Ridge, Chalillo (proposed dam), R. Macal, (site B9), 16°51'N88°00'W, 1286 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (reared) (BMNH). Mountain Pine Ridge, Rio On, (site B15), 16°59'N88°58'W, 1536 ft.; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (holoptic) (reared) (BMNH). Nr Caya [nr. El Cayo], Augustine; 27.vii.1961, (*D.J.Lewis*) – 23♀♀ (mule-biting) (BMNH).

SLIDE
Mountain Pine Ridge, San Ignacio-Las Cuevas Rd, before Guacamallo Bridge, Bailarina Camp, (site B7), 16°51'N88°59'W, 1294 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 4♀♀, 2♂♂ (holoptic), 10 (dichoptic) (reared) (BMNH). Mountain Pine Ridge, Chalillo (proposed dam), R. Macal, (site B9), 16°51'N88°00'W, 1286 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀, 2♂♂ (dichoptic) (reared) (BMNH). Augustine; 27.vii.1961, (*D.J.Lewis*) – 1♀ (man-biting) (BMNH).

SPIRIT
Mountain Pine Ridge, Guacamallo Bridge, R. Macal, (site B1), 16°51'N89°02'W, 1209 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 pupa (BMNH). Chiquibul Forest area, Natural Arch, nr. Arabato Camp, R. Chiquibul, (site B6), 16°37'N89°02'W, 1798 ft.; 9.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 pupa (BMNH). Mountain Pine Ridge, San Ignacio-Las Cuevas Rd, before Guacamallo Bridge, Bailarina

Camp, (site B7), 16°51'N88°59'W, 1294 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 12♀♀, 1♂ (holoptic), 2♂♂ (dichoptic) (reared) (BMNH). Mountain Pine Ridge, Chalillo (proposed dam), R. Macal, (site B9), 16°51'N88°00'W, 1286 ft.; 10.iii.2001, (*A.J.Shelley &*), *L.M.Hdez*) – 3♂♂ 2 ♂♂ (dichoptic) (reared), 2 pupae (BMNH).

Stann Creek District

PINNED

Southern Highway, South Stann Creek, (site B51), 16°43'N88°25'W, 372 ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀, 1♂ (dichoptic) (reared) (BMNH). Placencia-Middlesex rd. (Southern Highway), Mayflower Creek, (site B55), 16°56'N88°22'W, 294 ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2♂♂ (holoptic) (reared) (BMNH).

SLIDE

Punta Gorda-Placencia (Southern Highway), First creek (unnamed) after Santa Rosa Creek, (site B46), 16°40'N88°26'W; 21.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (man-biting) (BMNH). Southern Highway, South Stann Creek, (site B51), 16°43'N88°25'W, 372 ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (reared) (BMNH).

SPIRIT

Southern Highway, South Stann Creek, (site B51), 16°43'N88°25'W, 372 ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (reared), 1 pupa (BMNH). Hummingbird Highway, Northern Stann Creek, (S. Middlesex), (site B57), 17°00'N88°28'W; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (reared) (BMNH).

Toledo District

PINNED

Blue Creek-Santa. Theresa rd., Aguacate Creek, (site B27), 16°08'N89°00'W, 140 ft.; 18.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (reared) (BMNH). Southern Highway, Big Falls, Rio Grande, (site B35), 16°15'N88°53'W, 117 ft.; 20.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (reared) (BMNH).

ECUADOR
Esmeraldas Province

PINNED

Numerous reared adults from the following localities: San Miguel de Cayapas, R. Cayapa & R. San Miguel de Cayapas; 17–19.vi.1981, (*A.J.Shelley & M.Arzube*). Tumbaviro, R. Zapallo Grande; 26.v. & 18.vi.1981, (*A.J.Shelley & M.Arzube*). Viruela & Calle Mansa, R. Grande (Cayapa); 24–27.v.1981, (*A.J.Shelley & M.Arzube*). Naranjal, R. Canandé; 25.ix.1983 & 21–24.vi.1985, (*A.J.Shelley & M.Arzube*) (all BMNH).

SLIDE

San Miguel de Cayapas, R. San Miguel; 17.vi.1981, (*A.J.Shelley & M.Arzube*) – 3♀♀1♂ (reared) (BMNH). Calle Mansa, R. Grande (Cayapa); 27.v.1981, (*A.J.Shelley & M.Arzube*) – 1♂ (reared) (BMNH). Tumbaviro, R. Zapallo Grande; 24.v. & 18.vi.1981, (*A.J.Shelley & M.Arzube*) – 2♀♀2♂♂ (reared) (BMNH). Naranjal, Rio Canandé; 23 & 24.vi.1985, (*A.J.Shelley & M.Arzube*) – 1♂ (reared) (BMNH).

SPIRIT

Numerous reared adults and pupae from the following localities: San Miguel de Cayapas, R. Cayapa, & R.San Miguel de Cayapas; 17–19.vi.1981, (*A.J.Shelley & M.Arzube*). Tumbaviro, R. Zapallo Grande; 26.v. & 18.vi.1981, (*A.J.Shelley & M.Arzube*). Viruela & Calle Mansa, R.Grande (Cayapa); 24–27.v.1981, (*A.J.Shelley & M.Arzube*). Naranjal, R. Canandé; 25.ix.1983 & 21–24.vi.1985, (*A.J.Shelley & M.Arzube*) (all BMNH). Rio Camboyal; 20.ix.1984, (*M.L.Kuns*) – several ♀♀♂♂ and pupae (BMNH). Agua Blanca, R. Cayapa; 15.vii.1986, (*P.Beech*) – 1♀1♂ (reared), various ♀♀♂♂ (reared, pupal pelts missing) (BMNH). Agua Blanca, R.Cayapa; 28.xi.1988, (*M.L.Kuns*) – numerous ♀♀♂♂ and pupae (BMNH).

GUATEMALA
Chimaltenango Department

PINNED

Finca Sibaja; 6.xi.1974, (*R.Garms*) – 3♀♀ (BMNH).

Chiquimala Department

PINNED

Esquipulas, Rio Esquipulas, (No. Q-10); 14.i.1948, (*Onofre Ochoa A., H.T.Dalmat & Helvidio Ochoa*) – 1 pupa (BMNH).

Suchitepéquez Department

SLIDE

Municipio de Chicacao, Finca Valle de Oro, (site 3); 10.xi.1987, (*A.J.Shelley & W.S.Procunier*) – 1♂ (reared) (BMNH). Antigua, Finca Pastores, Rio Nahualate, (Nos. 25–25, 12N–13, 12N–14); 16.vi.1948, 8.vi.1951, (*H.T.Dalmat*), (*Armando Castellanos*), (*H.T.Dalmat & Armando Castellanos*) & (*Jaime Rosales & A.Castellanos*) – 2♀♀ (BMNH).

Chimaltenango Department

SPIRIT

Finca Santa Anita; 1.xii.1974, (*R.Garms*) – 3♀♀ (BMNH).

Quetzaltenango Department

SPIRIT

La Moka; 27.xi.1974, (*R.Garms*) – 3♀♀ (BMNH). Yepocapa; 1965, (*B.O.L.Duke*) – 1♀ (BMNH).

Suchitepequez Department

SPIRIT

Municipio de Chicacao, Finca Valle de Oro; 10.xi.1987, (*W.S.Procunier*) – 7♀♀2♂♂ (holoptic), 3 pupae (BMNH).

MEXICO
Chiapas State

SLIDE

Tapachula, Finca Hamburgo; 19.x.1985, (*H.Aguirre S.*) – 2♀♀ (man-biting) (BMNH).

San Luis Potosí State

PINNED

Tamazunchale, SLP; ix.1944, (*M.Macias*) – 1♀ (BMNH).

Veracruz State

SLIDE
Córdoba; 15.ii.1948, (*L.Vargas*) – 1 ♀(BMNH).

Simulium (*Psaroniocompsa*) *ganalesense* Vargas, Martínez Palacios & Díaz Nájera

TYPE MATERIAL

MEXICO
San Luis Potosí State

PINNED
Hacienda Ganales; 11.iv.1944, (*M.Macías G.*) – 1 ♀(90–024), 1 ♂(90–022) [PARATYPES] (INDRE).

SLIDE
Hacienda Ganales; 11.iv.1944, (*M.Macías G.*) – ♂ [HOLOTYPE, 3782] (INDRE). 1 ♂ with pupal gills [PARATYPE, 89043], 3 ♀♀ [PARATYPES, one as ALLOTYPE no 3843, one labelled as PARATYPE no.89044 and one we labelled as PARATYPE], 1 exuviae of ♀ pupa [PARATYPE, 89042] (INDRE). 1 ♀1 ♂, 1 mature pupa (♂) [PARATYPES] (USNM).

SPIRIT
Hacienda Ganales; 11.v.944, (*M.Macías G.*) – 8 pupae & 2 pupal exuviae [PARATYPES no. 66; 011 (87–122), 6 adults [probably females] in poor condition having previously dried out (no. 40; 011(87–121)] (INDRE). 1 ♀2 ♂♂,1 pupa [PARATYPES] (USNM).

OTHER MATERIAL

BELIZE
Stann Creek District

PINNED
Hummingbird Highway, Northern Stann Creek (Forest Department), (site B56), 16°59'N88°18'W, 101 ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 17 ♀♀ (man-biting) (BMNH)

SPIRIT
Hummingbird Highway, Northern Stann Creek (Forest Department), (site B56), 16°59'N88°18'W, 101, ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 13 ♀♀ (man-biting) (BMNH). Hummingbird Highway, Northern Stann Creek (S. Middlesex), (site B57), 17°00'N88°28'W; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2 ♀♀ (man-biting) (BMNH). Kendal, side pool of Sittee River at bridge; 2.v.1987, (*Spangler & Faitomte*) – 1 ♀(USNM).

Toledo District

PINNED
Southern Highway, Bladen Branch, (site B40), 16°28'N88°38'W, 191 ft.; 20.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 34 ♀♀ (man-biting), 1 ♂ (reared) (BMNH). Southern Highway, R. Swasey (under bridge), (site B41) 16°31'N88°33'W, 110 ft.; 20.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♀ (man-biting) (BMNH). Southern Highway, R. Swasey (up river), (site B43), 16°32'N88°32'W, 115 ft.; 21.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 13 ♀♀ (man-biting) (BMNH). Punta Gorda to Placencia (Southern Highway), small stream (un-named) after Little Dry Creek, (site B45), 16°36'N88°30'W, 187 ft.; 21.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♀(reared) (BMNH). Southern Highway, R. Swasey (up river), (site B48), 16°32'N88°32'W, 115 ft.; 24.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 13 ♀♀ (man-biting) (BMNH). Southern Highway, R. Swasey, at San Pablo, (site B50), 16°34'N88°32'W, 268 ft.; 24.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2 ♀♀ (man-biting) (BMNH).

SLIDE
Southern Highway, Bladen Branch, (site B40), 16°28'N88°38'W, 191 ft.; 20.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 11 ♀♀ (man-biting), 1 ♂ (reared) (only pupa & abdomen) (BMNH). Southern Highway, R. Swasey (under bridge), (site B41), 16°31'N88°33'W, 110 ft.; 20.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 5 ♀♀ (man-biting), 1 ♀(reared) (only pupa and abdomen) (BMNH). Southern Highway, Bladen Branch, (site B40), 16°28'N88°38'W, 191 ft.; 20.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 3 ♀♀(man-biting) (BMNH).

SPIRIT
Southern Highway, Bladen Branch, (site B40), 16°28'N88°38'W, 191 ft.; 20.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 54 ♀♀ (man-biting) (BMNH). Southern Highway, R. Swasey (under bridge), (site B41), 16°31'N88°33'W, 110 ft.; 20.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 44 ♀♀ (man-biting) (BMNH). Southern Highway, R. Swasey (up river), (site B43), 16°32'N88°32'W, 115 ft.; 21.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 51 ♀♀(man-biting) (BMNH). Punta Gorda to Placencia (Southern Highway), small stream (un-named) after Little Dry Creek, (site B45), 16°36'N88°30'W, 187 ft.; 21.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 pupa (BMNH). Southern Highway, R. Swasey (up river), (site B48), 16°32'N88°32'W, 115 ft.; 24.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 9 ♀♀ (man-biting) (BMNH).

Simulium (*Psilopelmia*) *callidum* Dyar & Shannon

TYPE MATERIAL

MEXICO
Veracruz State

PINNED
Córdoba; 16.iii.1908, (*Fredk Knab*) – ♀ [HOLOTYPE, no. 28677] [The holotype has no abdomen or wings, but a label 'slide' where these parts are presumed to be mounted. It bears a label by Malloch with *Simulium ochraceum* and one by Dyar & Shannon with *Eusimulium callidum.*] (USNM).

OTHER MATERIAL

BELIZE
Cayo District

PINNED
Mountain Pine Ridge, rd. to San Luis, small stream (unnamed), (site B2), 16°54'N88°54'W, 2260 ft., 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♂ (reared) (BMNH). Mountain Pine Ridge, Privación Creek, (site B3), 17°00'N88°53'W,

2163 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 19♀♀19♂♂ (reared) (BMNH). Chiquibul Forest area, Zaden Creek (Millonario), (site B11), 16°53'N89°00'W; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 7♀♀10♂♂ (reared) (BMNH). Mountain Pine Ridge, Mahogany Creek, (site B12), 16°55'N89°00'W; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2♀♀ (reared) (BMNH). Mountain Pine Ridge, Rio On, (site B15), 16°59'N88°58'W, 1536 ft.; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (reared) (BMNH). Mountain Pine Ridge, Blancaneaux Lodge, small stream into Privación Creek, (site B17), 17°02'N88°57'W, 1530 ft.; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀(reared) (BMNH). Chiquibul Forest area, Monkey Trail Branch, (site B18), 17°00'N89°58'W; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (reared) (BMNH). Mountain Pine Ridge, Rio Pinol, (site B19), 17°00'N88°58'W, 1389 ft.; 13.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀(reared) (BMNH). Mountain Pine Ridge, Oak Burn Creek, (site B20), 17°01,'N88°58'W, 1378 ft.; 13.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀1♂ (reared) (BMNH). Cool Shade; 14.i.1958, (*P.C.C.Garnham & D.J.Lewis*) – 1♀(at light) (BMNH). Cool Shade; 11.i.1958, (*P.C.C.Garnham & D.J.Lewis*) – 1♀ (on man) (BMNH).

SLIDE

Mountain Pine Ridge, rd. to San Luis, small stream (unnamed), (site B2), 16°54'N88°54'W, 2260 ft., 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2♀♀1♂ (reared) (BMNH). Mountain Pine Ridge, Privación Creek, (site B3), 17°00'N88°53'W, 2163 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (reared) (BMNH). Chiquibul Forest area, Zaden Creek (Millonario), (site B11), 16°53'N89°00'W; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 4♀♀4♂♂ (reared) (BMNH).

SPIRIT

Mountain Pine Ridge, Rd to San Luis, small stream (unnamed), (site B2), 16°54'N88°54'W, 2260 ft., 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (reared) (BMNH). Mountain Pine Ridge, Privación Creek, (site B3), 17°00'N88°53'W, 2163 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 7♀♀9♂♂ (reared) (BMNH). Chiquibul Forest area, Zaden Creek (Millonario), (site B11), 16°53'N89°00'W; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 4♀♀4♂♂ (reared), 2 pupae (BMNH).

Stann Creek District

PINNED

Hells Teeth; 10.ii.1958, (*P.C.C.Garham & D.J.Lewis*) – 1♀ (BMNH).

Toledo District

PINNED

Southern Highway, R. Swasey (up river), (site B43), 16°32'N88°32'W, 115 ft.; 21.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀(reared) (BMNH).

There is a total of 31 slides collected, prepared and identified by D.J.Lewis as *S. callidum*. Many of the slides contain more than one specimen and many of the specimens could not be identified without remounting. Slides where Lewis' s identification has been confirmed are marked with the stage of the specimen(s) and A.J.S. The following localities are registered where the identifications have been confirmed. **Cayo District**: Oak Burn; 31.ii.1958, (*P.C.C.Garham & D.J.Lewis*). San Luis; 23.1.1958, (*P.C.C.Garham & D.J.Lewis*). Little Vaqueros Creek; 25.i., 3.ii.1958, (*P.C.C.Garham & D.J.Lewis*). Dry Creek; 10.ii.1958, (*P.C.C.Garham & D.J.Lewis*). Rio Pinol; 31.i.1958, (*P.C.C.Garham & D.J.Lewis*). **Stann Creek District**: Hell's Teeth; 10.ii., 15.ii.1958; (*P.C.C.Garham & D.J.Lewis*).

COLOMBIA
Valle Department

PINNED

Pance; 13.xii.1976, (*M.A.Tidwell*) – 1♀ (man-biting) (BMNH).

COSTA RICA

PINNED

Potrero Grande, Rio Coto Brus; 3.vii.1993, (*T.Sheppard*) – 3♀♀ (BMNH).

Guanacaste Province

SPIRIT

Monteverde Reserve, stream beyond Ventana; 12.vii.1986, (*R.W.Lichtwardt*) – 4 pupae (BMNH). Monterverde Cloud Forest Reserve, Quebrada Cuecha; 11.vii.1986, (*R.W.Lichtwardt*) – several pupae (BMNH). Monterverde Cloud Forest Reserve, Quebrada Cuecha, along Sendero Rio; 21.vii.1986, (*R.W.Lichtwardt*) – 2 pupae (BMNH). Monteverde Reserve, Quebrada Cuechaon, Sendero Valle; 14.vii.1986, (*R.W.Lichtwardt*) – several pupae (BMNH).

San José Province

SPIRIT

7 km of Ciudad Colón on Route 7, small un-named creek; 5.xi.1984, (*R.W.Lichtwardt*) – 1 pupa (BMNH).

GUATEMALA
Chimaltenango Department

PINNED

Finca Santa Anita; 14.iii.1975, (*G.Garms*) – 1♀ (BMNH). Yepocapa, Tululché, R. Sacayó; 16.xi.1948, (*H.T.Dalmat*) – 1♀ (BMNH). Acatenango, L. Delicious, R. Cualiyój; 8.ix.1948, (*H.T.Dalmat*) – 1♀ (BMNH). Acatenango, Chakabal, R. Kikiyá; 15.xii.1948, (*H.T.Dalmat*) – 1♀♀ (BMNH). Yepocapa, Sta Cristi, R. Sta Cristi; 15.xi.1948, (*H.T.Dalmat*) – 1♂ (BMNH). Acatenango, Techuyá, R.Techuyá; 24.viii.1948, (*H.T.Dalmat*) – 1♂ (BMNH).

SPIRIT

Yepocapa area; 1965, (*B.O.L.Duke*) – 4♀♀ (BMNH). La Moka; 27.ii.1974, (*R.Garms*) – 5♀♀ (BMNH). Finca Santa Anita; 1.xii.1974, (*R.Garms*) – 4♀♀ (BMNH).

Quezaltenango Department

PINNED

La Moka (Yepocapa focus); 27.xi.1974, (*G.Garms*) – 2♀♀ (BMNH).

SLIDE

La Moka (Yepocapa focus); 27.xi.1974, (*G.Garms*) – 4 ♀♀ (man-biting) (BMNH).

HONDURAS
Cortés Department

SPIRIT
250 m from treatment point, 24 h post tr., 250 stream El Cacao; 23.ii, 24.iii.1984, (*L.Lacey*) – several pupae (BMNH).

MEXICO
Chiapas State

PINNED
Morelos, Huixtla; 30.vi.1985, (*A.L.Millest*) – 3♀♀ (man-biting) (BMNH). Acacoyagua, Golondrinas S.; 23.i.1987, (*A.L.Millest*) – 1♀ (BMNH). Escuintla, Xalapa, stream 1; 23.i.1987, (*A.L.Millest*) – 1♀ (reared) (BMNH). La Victoria; vii.1949, (*A.Díaz N*) – 3♀♀ (BMNH). Tapachula, Chespal; 10.ii. & 24.ii.1987, (*A.L.Millest*) – 2♂♂ (BMNH). Mapastepec, Nueva Casta Rica S; 17.x.1987, (*A.L.Millest*) – 1 (pupa) (BMNH). Mapastepec, 3 de Mayo; 13.x.1987, (*A.L.Millest*) – 2♂♂ (reared)(BMNH).

SLIDE
Bado Ancho; iv.1946, (*A. Díaz*) – 2 pupae (BMNH).

SPIRIT
Bado Ancho; iv.1946, (*A. Díaz*) – numerous pupae (BMNH). Temixco; 11.vii.1945, (*A.Díaz N.*) – several ♀♀♂♂ and pupae (BMNH).

Federal District

PINNED
Puebla Valle, Mrs. Evans Hacienda; xi.1925, (*A.D.Fraser*) – 4♀♀ (BMNH). Mexico City; xi.1925, (*A.D.Fraser*) – 1♀ (BMNH). Mexico City, near Necaxa Power Station; xi.1925, (*A.D.Fraser*) – 5♀♀ (BMNH). W. of Toluca, Valle Bravo; xi.1925, (*A.D.Fraser*) – 9♀♀ (BMNH).

Oxaca State

PINNED
Santiago La Lopa, La Lopa I; 27.i.1987, (*A.L.Millest*) – 1♀ (reared) (BMNH). S. Juan Yaee, Santiago Yagallo 3; 24.x.1998, (*A.L.Millest*) – 1♂ (reared) (BMNH). Pantelhó, Pantelhó 1; 9.xi.1987, (*A.L.Millest*) – 1♂ (reared) (BMNH).

Veracruz State

SPIRIT
La Quinta, Zongolica; 3.vi.1948, (*F.Reyes*) – 4♀♀3♂♂, 6 pupae (BMNH-Ex. London School of Hygiene and Tropical Medicine).

PANAMA

PINNED
Bambito, Rio Chiriqui Viejo, 1550 m; 28.vii.1979, (*P.S.Cranston*) – 1♀1♂ (BMNH, B.M.1979–125).

Coclé Province

SPIRIT
El Valle, La Reforma, R. Antón, 560 ; 1–6.vii.1985, (*A.J.Shelley*) – 1♂ (reared) (BMNH).

TRINIDAD

PINNED
Las Cuevas, 675 m; 1969, (*J.B.Davies*) – 1♀ (labelled 'bred', but pupa missing) (BMNH).

Simulium (*Psilopelmia*) *haematopotum* Malloch

TYPE ATERIAL

MEXICO
Veracruz State

PINNED
St. Lucrecia, La Oaxaqueña; x.1911, (*F.W.Urich*) – ♀ [LECTOTYPE] [man-biting] (USNM, Cat no. 15414).

as ***Simulium marathrumi*** **Fairchild**

PANAMA
Panama Province

PINNED
Rio Las Lajas; 20.xi.1939, [collector unknown, possibly *Fairchild*] – ♀ [HOLOTYPE, Cat No. 25750] (MCZ). Rio Las Lajas; 20.xi.1939, [collector unknown, possibly Fairchild] – 1♀ [PARATYPES, Cat No. 25750] (MCZ). Rio Las Lajas; 20.xi.1939, [collector unknown, possibly Fairchild]– 2♀♀ (USNM).

SLIDE
Rio Las Lajas, 20.xi.1939, [collector unknown, possibly Fairchild] – 1♂ [PARATYPE, Cat No. 25750] (MCZ).

OTHER MATERIAL

BELIZE
Belize District

SPIRIT
Placencia-Dandriga-La Democracia rd., (Coastal Highway), Mahogany Creek, (site B60), 17°14'N88°25'W, 96 ft.; 26.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 pupa (BMNH).

Cayo District

PINNED
San Ignacio area, Billy White Creek, (site B21), 17°12'N89°02'W, 266ft.; 14.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (reared) (BMNH). Central Farm, (ID 1758); 21.x.1971, (*R.Akers*) – 1♀2♂♂ (on *Zea mays*) (BMNH).

SLIDE
Mountain Pine Ridge, San Ignacio-Las Cuevas Rd before Guacamallo Bridge, Bailarina Camp, (site B7), 16°51'N88°59'W, 1294 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (man-biting) (BMNH).

SPIRIT
Central Farm, W. Highway, mile 15; 9.vii.1965, (*W.L.Hazse*) – 1♂ (at black light) (USNM). Central Farm, W. Highway, mile 68; 20.vi.1968, (*W.L.Hazse*) – 3♀♀2♂♂ (at black light) (USNM). Central Farm, W. Highway, mile 68; 29.vi.1968, (*W.L.Hazse*) – 3♀♀15♂♂ (at black light) (USNM). Moun-

tain Pine Ridge, Guacamallo Bridge, R. Macal, (site B1), 16°51'N89°02'W, 1209 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (man-biting) (BMNH). San Ignacio area, Billy White Creek, (site B21), 17°12'N89°02'W, 266ft.; 14.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀2♂♂(reared) (BMNH). San Ignacio area, Cadena Creek, (site B22), 17°19'N89°03'W, 385 ft.; 14.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2 pupae (BMNH).

Stann Creek District

PINNED

Placencia-Middlesex (SourthernHighway), small stream (unnamed), (site B52), 16°45'N88°23'W, 150 ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀♀ (man-biting), 1♂ (reared) (BMNH). Placencia-Middlesex rd. (Southern Highway), Mayflower Creek, (site B55), 16°56'N88°22'W, 294 ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2♀♀ (man-biting) (BMNH). Hummingbird Highway, Northern Stann Creek (Forest Department), (site B56), 16°59'N88°18'W, 101ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 12♀♀ (man-biting), 4♀♀10♂♂ (reared, one male without pupa) (BMNH).

SLIDE

Pomona, Ritchie's Farm; 8.ii.1958 (*P.C.C.Garnham & D.J.Lewis*) – 1♀ [in poor condition, only genital fork and abdomen; identified by Lewis as '*S. veracruzanum*?']. Punta Gorda to Placencia (Southern Highway), small stream (unnamed) after Little Dry Creek, (site B45), 16°36'N88°30'W, 187 ft.; 21.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 4♀♀ (man-biting) (BMNH). Southern Highway, R. Swasey, at San Pablo, (site B50), 16°34'N88°32'W, 268 ft.; 24.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 5♀♀ (man-biting) (BMNH). Hummingbird Highway, Northern Stann Creek (Forest Department), (site B56), 16°59'N88°18'W, 101, ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (man-biting) (BMNH). Middlesex, (ID No. 2349); 3.iv.1984, (*R.A.Dunn*) – 2♀♀(man-biting) (BMNH).

SPIRIT

Southern Highway, R. Swasey, at San Pablo, (site B50), 16°34'N88°32'W, 268 ft.; 24.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (reared) (BMNH). Southern Highway, South Stann Creek, (site B51), 16°43'N88°25'W, 372 ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (reared) (BMNH). Placencia-Middlesex, (Southern Highway), small stream (un-named, (site B52), 16°45'N88°23'W, 150 ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 3 pupae (BMNH). Hummingbird Highway, Northern Stann Creek (Forest Department) (site B56), 16°59'N88°18'W, 101, ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 6 pupae (BMNH). Hummingbird Highway, Northern Stann Creek, (S. Middlesex), (site B57), 17°00'N88°28'W; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 pupa (BMNH). Middlesex, (ID 2349); 3.iv.1984, (*R.A.Dunn*) – 11♀♀(man-biting) (BMNH).

Toledo District

PINNED

Southern Highway, R. Swasey (up river), (site B43), 16°32'N88°32'W, 115 ft.; 21.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 10♀♀1♂ (reared) (BMNH). Southern Highway, Cowpen, R. Swasey, (site B47), 16°34'N88°32'W, 268 ft.; 24.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2♀♀ (without pupa) (BMNH). Southern Highway, San Pablo, R. Swasey, (site B49), 16°34'N88°32'W, 268 ft.; 24.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2♀♀5♂♂ (reared) (BMNH). Southern Highway, San Pablo, R. Swasey, (site B50), 16°34'N88°32'W, 268 ft.; 24.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 31♀♀ (man-biting), 5♂♂ (BMNH).

SLIDE

Southern Highway, R. Swasey (up river), (site B43), 16°32'N88°32'W, 115 ft.; 21.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 4♀♀3♂♂ (reared) (BMNH). Southern Highway, San Pablo, R. Swasey, (site B50), 16°34'N88°32'W, 268 ft.; 24.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (reared) (BMNH). Hummingbird Highway, Northern Stann Creek (Forest Department), (site B56), 16°59'N88°18'W, 101, ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (reared) (BMNH).

SPIRIT

Punta Gorda-Medina Bank (Southern Highway), small stream (un-named), (site B42), 16°30'N88°28'W, 145 ft.; 20.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2 pupae (BMNH). Southern Highway, R. Swasey (up river), (site B43), 16°32'N88°32'W, 115 ft.; 21.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (man-biting), 2♂♂ (reared) (BMNH). Punta Gorda to Placencia (Southern Highway), small stream (un-named) after Little Dry Creek, (site B45), 16°36'N88°30'W, 187 ft.; 21.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 5♀♀ (man-biting) (BMNH). Punta Gorda-Placencia (Southern Highway), first creek (unnamed) after Santa Rosa Creek, (site B46), 16°40'N88°26'W; 21.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (man-biting) (BMNH). Southern Highway, Cowpen, R. Swasey, (site B47), 16°34'N88°32'W, 268 ft.; 24.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀1♂ (reared) (BMNH). Southern Highway, San Pablo, R. Swasey, (site B50), 16°34'N88°32'W, 268 ft.; 24.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 9♀♀ (man-biting) (BMNH). Hummingbird Highway, Northern Stann Creek (Forest Department), (site B56), 16°59'N88°18'W, 101 ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2♀♀5♂♂ (reared) (BMNH).

DOMINICAN REPUBLIC

PINNED

Puerto Plata, Pico El Murazo, North Slope near summit, 19°41'N70°57'W, 910 m; 28.xi.1992, (*J.Rawling, R.Davidson, M.Klingler & S.Thompson*) – 1♀1♂ (BMNH). Pedernales, 26 km, N. Cabo Rojo, 18°6'N71°38W', 730 m; 13.vii.1990, (*J.Rawling, C.Yong & S.Thompson*) – 6♀♀6♂♂ (BMNH).

SLIDE

Pedernales, 26 km, N. Cabo Rojo, 18°6'N71°38W', 730 m; 13.vii.1990, (*J.Rawling, C.Yong & S.Thompson*) – 2♀♀2♂♂ (BMNH).

GUATEMALA
Chimaltenango Department

PINNED

Finca Sibaja; 29.x.1974, (*R.Garms*) – 1♀ (BMNH). Escuintla, El Llano, Rio Michatoya, (Nos. 13Q–74, 13Q–65, 13Q–81, 13Q–102); 11.vii.1952, (*H.T.Dalmat*) – 2♀♀2♂♂ (BMNH, B.M.1962–675).

Huehuetenango Department

SLIDE
San Marcos, Rio entre Malacatán y Ayutla; 16.xii.1947, (*O.Ochoa & H.T.Dalmat*) – 1♂ (BMNH).

HONDURAS
Cortés Department

SLIDE
Nr. S.P. Sula, Potrerillos; 16.iii.1984, (*L.Lacey*) – 5♀♀ (man-biting) (BMNH).

SPIRIT
Nr. S.P. Sula, Potrerillos; 16.iii.1984, (*L.Lacey*) – several ♀♀ (man-biting) (BMNH).

JAMAICA

PINNED
Clarendon, Pindar River, nr. Kellits; 17.vii.1970, (*Joy Ferradane*) – 1♀ (reared) (BMNH).

MEXICO
Chiapas State

PINNED
Chiapas; [no date], (*de Corza*) – 1♀ (BMNH).

SLIDE
Tuxtla, Gutierres, Pan American Highway nr. Guatemala; 14.iii.1953, (*J.Smart*) – 4♀♀ (BMNH). Tapachula, Finca Hamburgo; 19.x.1985, (*H.Aguirre S.*) – 1♀ (man-biting) (BMNH).

SPIRIT
Tuxtla, Gutierres, Pan American Highway nr. Guatemala; 14.iii.1953, (*J.Smart*) – numerous ♀♀ (man-biting) (BMNH).

Veracruz State

PINNED
St. Lucrecia, V. Cruz; 21.vi.1905, (*Frederick Knab*) – 1♀ (BMNH).

SLIDE
Jesús Carranza, (No. 6000); iii.1946, (*J.Parra*) – 1♀1♂ (only genitalia) (BMNH).

PANAMA
Coclé Province

PINNED
San Carlos, 8°25'N 80°0'W; 1.i.1983 & 7.i.1983, (*R.A.Cheke*) – 4♀♀ (man-biting) (BMNH). El Valle, Rio Antón, 1 ½ km above bridge at San Carlos; 1–6.vii.1985 (*A.J.Shelley*) – 8♀♀ (man-biting), 3♀♀9♂♂ (reared) (BMNH).

SLIDE
San Carlos, 8°25'N 80°0'W; 1.i.1983 & 7.i.1983, (*R.A.Cheke*) – 1♀ (man-biting) (BMNH). El Valle, Rio Antón, 1 ½ km above bridge at San Carlos; 1–6.vii.1985 (*A.J.Shelley*) – 1♀ (man biting) 2♂♂ (reared) (BMNH).

SPIRIT
San Carlos, 8°25'N 80°0'W; 1.i.1983 & 7.i.1983, (*R.A.Cheke*) – 2♀♀ (man-biting, 17:30–17:45 hours) (BMNH). El Valle, Rio Antón, 1 ½ km above bridge at San Carlos, (P4); 1–6.vii.1985 (*A.J.Shelley*) – 2♀♀(reared) 8♂♂(reared) numerous pupae (BMNH).

PUERTO RICO

PINNED
Isabela, Bosque Estatal de Guajataca, Montañas Aymamon, 18°26'N66°57'W, 210 m; 14–15.vi.1996, (*J.Rawling, W.Zanal, R.Davidson, C.Yong, M.Klingler & S.Thompson*) – 7♀♀5♂♂ (BMNH).

SLIDE
Isabela, Bosque Estatal de Guajataca, Montañas Aymamon, 18°26'N66°57'W, 210 m; 14–15.vi.1996, (*J.Rawling, W.Zanal, R.Davidson, C.Yong, M.Klingler & S.Thompson*) – 2♀♀2♂♂ (BMNH).

Simulium (*Psilopelmia*) *ochraceum* Walker (complex)

TYPE MATERIAL

MEXICO
Chiapas State

PINNED
Huixtla, Morelos; 30.vi.1985, (*A.L.Millest*) – ♀ (man-biting) [NEOTYPE] (BMNH).

OTHER MATERIAL

BELIZE
Cayo District

PINNED
Mountain Pine Ridge, small stream (un-named) before Bailarina Camp, (site B8); 16°51'N88°59'W, 1376 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (reared) (BMNH).

SLIDE
Mountain Pine Ridge, small stream (un-named) before Bailarina Camp, (site B8); 16°51'N88°59'W, 1376 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 (pupa) (BMNH).

ECUADOR

PINNED
Cotopaxi, San Francisco de las Pampas, Otonga, 2600 m; 22.iii.1993, (*J.Hillman*) – 2♀♀ (collected in undisturbed cloudforest).

GUATEMALA
Acatenango Department

SLIDE
R. Panocal; 8.vi1949, (*H.T.Dalmat*) – 1♂ (BMNH).

Chimaltenango Department

PINNED
Finca Santa Anita; 8.iii.1974, (*R.Garms*) – 3♀♀ (BMNH). Acantenango; 2.x.1948 & 8.vi.1949, (*H.Dalmat*) – 2♀♀3♂♂ (BMNH).

SLIDE
Finca Santa Emilia; 21.iii.1974, (*R.Garms*) – 2♀♀ (BMNH). Finca Santa Anita; 8.iii.1974, (*R.Garms*) – 1♀ (only cibarium) (BMNH). Yepocapa area; 1965, (*B.O.L.Duke*) – 7♀♀ (BMNH).

SPIRIT
Finca Santa Emilia; 21.iii.1974, (*R.Garms*) – 5♀♀ (BMNH). Yepocapa; [no date or collector] – numerous females (BMNH). Yepocapa area; 1965, (*B.O.L.Duke*) – numerous females (BMNH). El Brote, Parque Nacional Atitlan, border between Suchitepequez and Solola Provinces; 7.ii., 8.ii.1987, (*J.Davies*) – numerous females (BMNH).

JAMAICA

PINNED
[no locality or date], (*A.G.Johnston*) – 1♀ [the specimen bears a label '*S. antillarum*'] (BMNH).

MEXICO
Chiapas State

PINNED
Chalchihuitan; 4.xii.1940, (*J.Parra*) – 3♀♀ (BMNH). Huixtla; x.1958, (*R.W.Crosskey*) – 10♀♀ (BMNH). Huixtla, Morelos; 29.vi, 30.vi.1985 & 25.i.1987, (*A.L.Millest*) – 27♀♀ (man-biting). Acocuyagua, Golondrinas; 22.i.1987, (*A.L.Millest*) – 7♀♀ (man-biting) (BMNH). Tapachula, Chespal; 10.ii.1987, (*A.L.Millest*) – 14♀♀ (man-biting) (BMNH). Chespal, near N.E.1.; 18.vii.1985, (*A.L.Millest*) – 1♀ (man-biting) (BMNH). Escuintla, Xalapa; 24.i.1987, (*A.L.Millest*) – 7♀♀ (man-biting) (BMNH). El Bosque, Los Angeles, (CH–43, 44); 6.xi.1987, (*A.L.Millest*) – 1♀ (reared) (BMNH). Tuzantan, San Cristobal, W.I.; 22.vii.1986, (*A.L.Millest*) – 3♀♀1♂ (reared) (BMNH).

SLIDE
Huixtla; [no date or collector] – 8♀♀ (man-biting (BMNH). Huixtla; [no date or collector] – 1♀ (BMNH). Morelos, nr. Huixtla; 22.xi.1979, (*C.Mackenzie*) – 7♀♀ (BMNH). Unión Fronteriza; v.1952, (*A.Alvarado*) – 1♀ (BMNH). Guadalupe Zajú; iii.1946, (*A.Díaz N.*) – 1 pupa (BMNH).

SPIRIT
Huixtla; [no date or collector] – numerous females (BMNH). Colonia Morelos; 1954, (*V.Marraquin*) – numerous females (BMNH). Morelos, nr. Huixtla; 22.xi.1979, (*C.Mackenzie*) – numerous females (BMNH). Guadalupe Zajú; iii.1946, (*A.Díaz N.*) – several ♂♂♀♀ (reared) (BMNH).

PANAMA
Chiriqui Province

PINNED
Los Planes de Hornito; 12.ix.1978, (*J.Petersen*) – 1♀ (BMNH).

SPIRIT
Los Planes de Hornitos, 8°38'N82°14'W, (E46); 12.ix.1978, (*J.Petersen*) – 1♀2♂ (BMNH).

as ***S. bipunctatum*** Malloch

BRAZIL
Amazonas State

PINNED
Amazonas, Igarapé Tiquié, tributary of R. Vaupes; 15.xii.1977, (*C.Vicente*) – 10♀♀ (BMNH, IOC).

Roraima State

PINNED
Roraima, MEVA Mission post, Auaris; 7.vii.1976, (*A.J.Shelley*) (BMNH) – 3♀♀ (BMNH).

SLIDE
Amazonas, Igarapé Tiquié, tributary of R. Vaupes; 15.xii.1977, (*C.Vicente*) – 4♀♀ (man–biting) (BMNH).

COLOMBIA

PINNED
Norte de Santander, Arboledas, Siravita, La Esperanza; 25.xi.1984, (*B.Alexander*) – 3♀♀ (BMNH).

DOMINICA

PINNED
Roseau; 7.vii.1974, (*L.J.Charles*) – 6♀♀ (BMNH).

DOMINICAN REPUBLIC

PINNED
La Vega, near mouth Arroyo Los Dajaos, 5 km E Manabo, 740 m, 19°04'N70°45'W; 9.xi.1991, (*J.Rawlins, R.Davidson, C.Young & S.Thompson*) – 7♀♀ (in riparian woodland) (BMNH). Dajabon, 9 km Loma de Cabrera, 19°21'N71°37'W; 2.vii.1992, (*J.Rawlins, S.Thompson, C.Young & R.Davidson*) – 4♀♀ (BMNH). Independencia, 4 km S Los Pinos, Loma de Vientos, 18°35'N7116746'W, 455 m; 23.vii.1992, (*R.Davidson, J.Rawlins, S.Thompson & C.Young*) – 5♀♀ (BMNH). San Juan, 7 km S Arroyo Cano, 1 km S Los Frios, 18°52'N71°01'W; 1.ix.1995, (*J.Rawlins, G.Onore & R. Davidson*) – 1♀ (BMNH). El Seibo, Loma Cocuyo, 6 km N Pedro Sanchez, 18°55'N69°N07'W; 4.ix.1992, (*C.Young R. Davidson S.Thompson*) – 4♀♀ (field and woods) (BMNH). Barahona, 6 km NW Paraiso, Rio Nizao, 18°02'N71°12W, 170 m; 25–16.vii.1990, (*C.Young, C.Young & S.A.Thompson*) – 1♀ (BMNH). Puerto Plata, Pico El Murazo, north slope near summit, 19°41°70°57', 910 m; 28.xi.1992, (*J.Rawlins, R. Davidson, M.Kingler & S.Thompson*) – 2♀♀3♀♀ (BMNH).

ECUADOR
Esmeraldas Province
Numerous reared adults and pupae PINNED, SLIDE and in SPIRIT from the following localities in the Santiago onchocerciasis focus: R. Cayapa; 18–21.vi.1981, (*A.J. Shelley & M.Arzube*) (BMNH). R. Cayapa, stream 4 km below San Miguel de Cayapas; 17.vi.198; (*A.J.Shelley & M.Arzube*) (BMNH). R. Cayapa, above Sapallo Grande Mission; 28.v.1981, (*A.J. Shelley & M.Arzube*) (BMNH). R. San Miguel, small stream 100 m above San Miguel de Cayapas; 17.vi.198, (*A.J. Shelley & M.Arzube*) (BMNH). R. San Miguel de Cayapas, Estero Hacha; 26.v.1981, (*A.J.Shelley & M.Arzube*) (all BMNH).

JAMAICA

PINNED

Loaf Water; 6.iii.1958, (*D.J.Lewis*) – 8♀♀ (BMNH) [There is a total of 9 slides collected with same previous locality data, prepared and identified by D.J.Lewis as *S. antillarum*. Many of the slides contain more than one specimen and they are not in good condition. Slide where Lewis identification has been confirmed are marked with a label A.J.Shelley (all BMNH)]. Pindars River, near Kellits; 17.vii.1970, (*Clarendon*) – 2♀♀2♂♂ (ex pupae) (BMNH).

MONTSERRAT

PINNED

Montserrat Woodlands; 20.ix.1938, (*F.A.S.*) – 4♀♀ (BMNH).

PUERTO RICO

PINNED

Cayey, Bosque Estatal de Caripe, 4.2 km SE Campamento Guavate, 18°05'25"N66°02'07"W, 580 m; 7.vi.1996, (*C.Young, R. Davidson, C.Young, S.Thompson & W.Zanol*) – 9♀♀6♂♂ (BMNH).

VENEZUELA

Monagas State

PINNED

Localities near San Antonio de Maturin, v.1961 (*D.J.Lewis*) – 8♀♀, 10 pupae [labelled by Lewis as sp. D and regarded by Ramírez Pérez as *S. pseudoantillarum*] (BMNH). [There is a total of 18 slides collected, prepared and identified by D.J.Lewis and labelled 'Sp. D'. Many of the slides contain more than one specimen and many of the specimens could not be identified without remounting. Slides where Lewis' s identification of *S. ochraceum* (identified by Lewis as *S. bipunctatum*) has been confirmed are marked with a label 'Det.: A.J.Shelley' (BMNH).

Simulium (*Psilopelmia*) *quadrivittatum* Loew, 1862

BELIZE

Belize District

SPIRIT

Placencia-Dandriga-La Democracia rd. (Coastal Highway), Mahogany Creek, (site B60), 17°14'N88°25'W, 96 ft.; 26.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 pupa (BMNH).

Cayo District

PINNED

Mountain Pine Ridge, Chalillo (proposed dam), R. Macal, (site B9), 16°51'N88°00'W, 1286 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 4♀♀ (man-biting) (BMNH). Chiquibul Forest area, Zaden Creek (Millonario), (site B11), 16°53'N89°00'W; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 20♀♀ (man-biting) (BMNH). Mountain Pine Ridge, Blancaneaux Lodge (dam), (site B16), 17°02'N88°57'W, 1530 ft; 11.iii.2001, (*A.Shelley & L.M.Hdez*) – 1♀ (man-biting) (BMNH). Privación Creek, 31.ii.1958, (*D. J. Lewis*) – 34♀♀ (BMNH). Near Cayo, Augustine; 27.vii.1961, (*D. J. Lewis*) – numerous females (man-biting) (BMNH). Middlesex, 8.ii. & 17.ii.1958, (*D.J.Lewis*) – 3♀♀ (man-biting) (BMNH). Cool Shade, 1.i. 1958 (*D. J.Lewis & P. C. C.Garnham*) – 2♀♀ (BMNH). North Branch, 10.ii.1958, (*D.J.Lewis*) – 1♀ (BMNH). Rio Frio; 5.ii.1958, (*P.C. C.Garnham & D.J.Lewis*) – 3♀♀ (BMNH).

SLIDE

Privación Creek; 31.i.1958, (*D.J.Lewis*) – 2♀♀ (man-biting) (BMNH). Mountain Pine Ridge, San Ignacio-Las Cuevas rd., before Guacamallo Bridge, Bailarina Camp, (site B7), 16°51'N88°59'W, 1294 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 6♀♀ (man-biting) (BMNH). Mountain Pine Ridge, Chalillo (proposed dam), R. Macal, (site B9), 16°51'N88°00'W, 1286 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 6♀♀ (man-biting) (BMNH).

SPIRIT

Augustine (8 km N), collected at Little Vaqueros Creek, 450 alt; 25.v.1986, (*P.J.Spangler & R.A.Faitoute*) – 1♀(USNM). Mountain Pine Ridge, Rd to San Luis, small stream (un-named), (site B2), 16°54'N88°54'W, 2260 ft., 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 35♀♀ (man-biting) (BMNH). Mountain Pine Ridge, Privación Creek, (site B3), 17°00'N88°53'W, 2163 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 4♀♀ (man-biting) (BMNH). Privación Creek; 31.i.1958, (*D. J.Lewis*) – several ♀♀ (man-biting) (BMNH). Chiquibul Forest area, Las Cuevas Research Station, (site B4), 16°44'N88°59'W, 1640 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀(man-biting) (BMNH). Chiquibul Forest area, nr. Las Cuevas Research Station, Grano de Oro, (site B5), 16°40'N89°01'W, 1874 ft.; 9.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (man-biting) (BMNH). Grano de Oro; 18.vii.2002, (*M.Penn*) – 7♀♀ (man-biting) (BMNH). Mountain Pine Ridge, San Ignacio-Las Cuevas rd, before Guacamallo Bridge, Bailarina Camp, (site B7), 16°51'N88°59'W, 1294 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 23 ♀♀ (man-biting) (BMNH). Mountain Pine Ridge, small stream (un-named) before Bailarina Camp, (site B8); 16°51'N88°59'W, 1376 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 17♀♀ (man-biting) (BMNH). Mountain Pine Ridge, Chalillo (proposed dam), R. Macal, (site B9), 16°51'N88°00'W, 1286 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 13♀♀ (man-biting) (BMNH). Chiquibul Forest area, Zaden Creek (Millonario), (site B11), 16°53'N89°00'W; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 5♀♀ (man-biting) (BMNH). Mountain Pine Ridge, Mahogany Creek, (site B12), 16°55'N89°00'W; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 3♀♀ (man-biting) (BMNH). Mountain Pine Ridge, small stream (un-named), between Mahogany Creek & Paddy Creek (site B13), 16°56'N89°00'W, 1583 ft.; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 5♀♀ (man-biting) (BMNH). Mountain Pine Ridge, Paddy Creek, (site B14), 16°56'N89°00'W, 1455 ft.; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 8♀♀ (man-biting) (BMNH). Mountain Pine Ridge, Blancaneaux Lodge (dam), (site B16), 17°02'N88°57'W, 1530 ft; 11.iii.2001, (*A.Shelley & L.M.Hdez*) – 3♀♀ (man-biting) (BMNH). Mountain Pine Ridge, Hidden Valley, 1000 Ft Falls, 17°03'N88°50'W, 1000 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 3♀♀ (man-biting) (BMNH).

Stann Creek District

PINNED

Placencia-Middlesex (Sourthern Highway), small stream (unnamed), (site B52), 16°45'N88°23'W, 150 ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 3♀♀ (man-biting), 1 (reared) (BMNH). Placencia-Middlesex rd. (Southern Highway), Mayflower Creek, (site B55), 16°56'N88°22'W, 294 ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (man-biting) (BMNH).

SLIDE

Placencia-Middlesex (Southern Highway), small stream (unnamed), (site B52), 16°45'N88°23'W, 150 ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (reared) (BMNH).

Toledo District

SPIRIT

Punta Gorda-Manfredi-Blue Creek rd., Manfredi Creek, (site B25), 16°14'N89°59'W, 189 ft.; 17.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 pupa (BMNH). Santa Theresa-San Lucas rd., Go to Hell Creek, (site B28), 16°004'N89°06'W, 234 ft.; 18.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (without pupa) (BMNH). Jalacte-Santa Elena-Pueblos rd., Black Creek, (site B34), 16°11'N89°10'W, 955 ft.; 19.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 pupa exuvia (BMNH).

There is a total of 7 slides collected, prepared and identified by D.J.Lewis of *S. quadrivittatum*. Many of the slides contain more than one specimen and many of the specimens could not be identified without remounting. Slides where Lewis' s identification has been confirmed are marked with the stage of the specimen(s) and L.M.Hernández. The following localities are registered where identifications have been confirmed. **Cayo District**: Stream near Vaqueros Creek; 3.ii.1958, (*P.C.C.Garnham & D.J.Lewis*). Privación Creek; 31.1.1958, (*P.C.C.Garnham & D.J.Lewis*).

COLOMBIA

PINNED

Choco, El Tigre; x.1959, (*P.C.C.Garnham*) – 1♀ (BMNH).

COSTA RICA
Cartago Province

PINNED

Orosí; 6.i.1938, (*H.W.Kumm*) – 4♀♀ (BMNH, B.M.1938–202). Env. Da Cártago & La Palma,1500 m; [no date], 1906 (*Biolley*) – 1♀ (BMNH) [this specimen was presented by Roubaud with incomplete data but almost certainly from the series deposited by Biolley in MNHN]. Talamanca; 22.iv.1917, (*C.B.Williams*) – 1♀ (man-biting) (BMNH). C.A.T.I.E., Turrialba; 24.vii.1944, (*R.A.Cheke*) – 9♀♀ (man-biting) (BMNH).

Limón Province

PINNED

Siquirres; 1.vi.1938, (no collector) – 5♀♀ (BMNH-Ex. London School of Hygiene & Tropical Medicine, B.M.1995–264).

CUBA

PINNED

Cayamas; 11.vi. (no date), (*E.A.Schwarz*) – 2♀♀ (USNM) [One of these females is labelled as a cotype (No. 41595) of *S. haematopotum*, by Malloch but is in fact *S. quadrivittatum* and we have added a label that this specimen has no type status]

SPIRIT

Hotel Moka, Las Terrazas, on verandah bar, about 12km from Havana Airport; 3.iii.1999, (*J.Davies*) – 9♀♀ (man-biting) (BMNH). 3–4 km from Hotel Moka, Las Terrazas; Rio San San Juan; 4.iii.1999, (*J.Davies*) – numerous larvae and pupae (BMNH).

DOMINICAN REPUBLIC

PINNED

El Seibo, Loma Cocuyo, 6 km N. Pedro Sanchez, 18°55N69°07'W, 475m; 4.vii.1992, (*R.Davidson, J.Rawlins & S.Thompson*) – 4♀♀ (BMNH). Las Vegas, near Mouth Arroyo Los Dajaos, 5 km E Manabo, 19°04N70°45'W, 740 m; 9.xi.1991, (*J.Rawlins, R.Davidson, C.Young & S.Thompson*) – 2♀♀ (BMNH). Dajabón, 9km S Loma de Cabrera, 19°21'N71°37'W, 620 m; 12.vii.1992, (*J.Rawlins, S.Thompson, C. Young & R. Davidson*) – 5♀♀ (in disturbed and mesic woodlands) (BMNH). Barahona, 6 km NW Paraiso, Rio Nizao, 18°02'N71°12W, 170 m; 25–16.vii.1990, (*C.Young, C.Young, S.A.Thompson*) – 4♀♀8♂♂ (BMNH). Hato Mayor, Parque Los Haitises, E. of Trepada Alta, 12km W El Valle, 18°59'N69°39'W, 145m; 6.vii.1992, (*J.Rawlins, S.Thompson, C.Young & R.Davidson*) – 4♂♂ (mesic forest on limestone) (BMNH). Puerto Plata, Pico El Murazo, north slope near summit, 19°41°70°57', 910 m; 28.xi.1992, (*J.Rawlins, R. Davidson, M.Kingler & S.Thompson*) – 3♀♀10♂♂ (in deciduous forest) (BMNH).

SLIDE

Barahona, 6 km NW Paraiso, Rio Nizao, 18°02'N71°12W, 170 m; 25–16.vii.1990, (*C.Young, S.A.Thompson*) – 2♂♂ (BMNH). Puerto Plata, Pico El Murazo, north slope near summit, 19°41°70°57', 910 m; 28.xi.1992, (*J.Rawlins, R. Davidson, M.Kingler & S.Thompson*) – 2♂♂ (BMNH).

ECUADOR
Cotopaxi Province

PINNED

Quevedo-La Maná-Pilaló road, La Germania, Riachuelo; 9.vi.1984, (*A.J.Shelley & M.Arzube*) – 2♀♀ (reared) (BMNH)

El Oro Province

PINNED

Machala-Naranjal road, Rio Bucay; 12.vi.1984, (*M.Arzube*) – 2♀♀ (man-biting) (BMNH).

Esmeraldas Province

PINNED

San Miguel de Cayapas, R. Cayapa; 25.iv.1981, (*A.J.Shelley & M.Arzube*) – 8♀♀ (man-biting) (BMNH). Sapallo Grande Mission, R. Cayapa; 28.v.1981, (*A.J.Shelley & M.Arzube*) – 1♀ (man-biting) (BMNH). R. Cayapas, 0°42'N78°54'W; 25.vi.1980, (*M.E.Arzube R.*) – 7♀♀ (BMNH). 4 km below San Miguel de Cayapas. R. Cayapa, Cascadita 13; 17.vi.1981, (*A.J.Shelley & M.Arzube*) – 1♀ (reared) (BMNH). San Miguel

de Cayapas, R. San Miguel, feeder stream; 17.iv.1981, (*A.J.Shelley & M.Arzube*) – 1♂ (reared) (BMNH). Naranjal, R. Canandé; 25.ix.1983, (*A.J.Shelley & M.Arzube*) – 3♀♀ (BMNH). Naranjal (R. Canandé), Rio Aguas Negras; 23.vi.1985, (*A.J.Shelley & M.Arzube*) – 1♀ (BMNH).

SLIDE
San Miguel de Cayapas, R. San Miguel; 28–30.vi.1980, (*M.Arzube*) – 4♀♀ (man-biting) (BMNH). San Miguel de Cayapas, R. San Miguel, feeder stream; 17.iv.1981, (*A.J.Shelley & M.Arzube*) – 1♂ (only abdomen, genitalia & hind leg) (BMNH). Naranjal (R. Canandé), Rio Aguas Negras; 23.vi.1985, (*A.J.Shelley & M.Arzube*) – 1♀ pupa exuviae (BMNH).

SPIRIT
Rio Santiago, stream behind Palma Real; 14.xii.1986, (*P.Beech-Garwood*) – pupal exuviae (BMNH). Rio Santiago, Angostura; 7.viii.1986, (*P.Beech*) – 5♀♀ (man-biting) (BMNH). Calamansa, R. Cayapa, Tienda Humberto Quintero; 22.xi.1984, (*M.L.Kuns*) – several ♀♀ (man-biting) (BMNH). Calamansa, R. Cayapa; 22.xi.1984, (*M.L.Kuns*) – 7♀♀ (man-biting) (BMNH). Between San Miguel and Sapallo Grande Mission, R. Cayapa, small stream, (E1981–18); 22.vi.1981, (*A.J.Shelley & M.Arzube*) – 1♀ (man-biting) (BMNH). San Miguel de Cayapas; 28–30.vii.11980, (*M.E.Arzube R.*) – 4♀♀ (man-biting) (BMNH). Naranjal, R. Canandé, Calle Mansa, Riachuelo (E.43–A); 25.ix.1983, (*A.J.Shelley & M.Arzube*) – 1♀ (man-biting) (BMNH). Naranjal, R. Canandé; 22.vi.985, (*A.J.Shelley & M.Arzube*) – several ♀♀ (man-biting) (BMNH). Naranjal, R. Canandé (E 44); 25.xi.1983, (*A.J.Shelley & M.Arzube*) – 3♀♀ (man-biting). Naranjal, R. Canandé, R. Naranjal; 3.vi.1988, (*A.J.Shelley & M.Arzube*) – several ♀♀ (man-biting) (BMNH). Naranjal (R. Canandé), Rio Aguas Negras; 23.vi.1985, (*A.J.Shelley & M.Arzube*) – 3♀♀ (man-biting) (BMNH). Naranjal, Riachuelo Aguas Negras; 25.ix.1983, (*A.J.Shelley*) – 1♀ (man-biting) (BMNH). San Miguel de Cayapas, Estero Hacha; 26.v.1989, (*A.J.Shelley & M.Arzube*) – 1♀ (man-biting), 1 pupa (BMNH). Tululbi (Ricuarte), R. Bogotá; 9.ix.1983, (*A.J.Shelley & M.Arzube*) – 1♀ (BMNH). Santo Domingo-Esmeraldas road, R. Miringo; 24.ix.1983, (*A.J.Shelley & M.Arzube*) – 2♀♀ (man-biting) (BMNH).

Manabi Province

PINNED
Santa Domingo-El Carmen road, km 40, 2 km past El Carmén, Rio Suma; 7.vi.1984 (*A.J. Shelley & M.Arzube*) – 1♀ (BMNH).

GUATEMALA
El Petén Department

PINNED
Tikal; 9.xi.1974, (*R.Garms*) – 1♀ (BMNH).

JAMAICA

PINNED
Kew Park; vi.1929, (*G.B.Williams*) – 1♀ (BMNH-ex. London School of Tropical Medicine and Hygiene, B.M.1995–264). [no locality or collection date], (*H. G. Johnson*) – 14♀♀ (BMNH-ex. London School of Tropical Medicine and Hygiene, B.M.1995–264).

MEXICO
Veracruz State

SLIDE
Las Chuapas; ii.1947, (*J. Parra*) – 1♀ (on five slides), 1♂ (on five slides), 1 pair of pupa gills (BMNH).

PANAMA
Chiriqui Province

PINNED
Fortuna, Arroyo 47, Pastizal; Chiriqui, R. de Panama; 22.i.1981, (*J.L.P.*) – 3♀♀ (BMNH).

Panama Province

PINNED
Canal Zone; 1932, (*L.H.Dunn*) – 8♀♀ (glued on the same card) (BMNH).

SLIDE
Canal Zone; 193, (*L.H.Dunn*) – 1♀ (only thorax, abdomen and fore and hind leg) (BMNH)

PUERTO RICO

PINNED
Cayey, Bosque Estatal de Caripe, 4.2 km SE Campamento Guavate, 18°05'25"N66°02'07"W, 580 m; 7.vi.1996, (*C.Yonng, R. Davidson, C.Yonng, S.Thompson & W.Zanol*) – 2♂♂ (BMNH).

Simulium (*Psilopelmia*) *samboni* Jennings, 1915

TYPE MATERIAL

PANAMA

PINNED
Empire, Canal Zone, tributary of R.Comacho, (872); 4.x.1913, (*A.H.Jennings*) – ♀ [HOLOTYPE, as Type No. 19996] (USNM). Empire, Canal Zone, tributary of R. Comacho, (872); 4.x.1913, (*A.H.Jennings*) – 4♂♂ [complete], 2♂♂ [without head, wings, legs and abdomen] [PARATYPES, USNM No. 19996).

SLIDE
Empire, Canal Zone, tributary of R.Comacho, (872); 4.x.1913, (*A.H.Jennings*) – 2♂♂ [PARATYPES, one labelled as ALLOTYPE with 1 wing and 1 gonostyle and gonocoxite, the other labelled as TYPE with head, thorax and abdomen but no wings or legs] (USNM).

OTHER MATERIAL

BELIZE
Belize District

SPIRIT
Dandriga-La Democracia rd. (Coastal Highway), small stream (un-named), (site B58), 17°09'N88°21'W, 123 ft.; 26.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 pupa (BMNH).

Cayo District

PINNED

Mountain Pine Ridge, Privación Creek, (site B3), 17°00'N88°53'W, 2163 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♀ (reared) (BMNH). Mountain Pine Ridge, R. Frio Cave, (site B10) 16°59'N88°00'W, 1430 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2 ♀♀ 2 ♂♂ (reared) (BMNH). Mountain Pine Ridge, Mahogany Creek, (site B12), 16°55'N89°00'W; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 3 ♀♀ (reared) (BMNH). Mountain Pine Ridge, Rio On, (site B15), 16°59'N88°58'W, 1536 ft.; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 5 ♀♀ 3 ♂♂ (reared) (BMNH). Chiquibul Forest area, Monkey Trail Branch, (site B18), 17°00'N89°58'W; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 4 ♀♀ 2 ♂♂ (reared) (BMNH). Chiquibul road, Tower: ground; 30.i.1967, (*D.S.Bertram*) – 6 ♀♀ (BMNH) [these specimens bear a label '2 day-biting spp. *Simulium*' and were identified as *S. callidum*, but the specimens are in fact *S. samboni* and were probably collected 'landing on human bait' as noted for the species in the current work]. San Antonio area; 20.i, 21.i, 22.i, 27.i.1966, (*R.H.L.Disney*) – several ♀♀ (BMNH).

SLIDE

Mountain Pine Ridge, Privación Creek, (site B3), 17°00'N88°53'W, 2163 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♀ 1 ♂ (reared) (BMNH). Mountain Pine Ridge, R. Frio Cave, (site B10) 16°59'N88°00'W, 1430 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♂ (reared) (BMNH). Mountain Pine Ridge, Mahogany Creek, (site B12), 16°55'N89°00'W; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♀ (reared) (BMNH). Chiquibul road, Tower, 40 ft platform; 9.i.67, [no collector cited] – 4 ♀♀ (collected at 8:30–15:00) (BMNH). Mountain Pine Ridge, Paddy Creek, (site B14), 16°56'N89°00'W, 1455 ft.; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♀ (reared). Chiquibul Forest area, Monkey Trail Branch, (site B18), 17°00'N89°58'W; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2 ♀ 1 ♂ (reared) (BMNH). Chiquibul road, Tower, 40 ft platform; 9.i.67, [no collector cited] – 4 ♀♀ (collected at 8:30–15:00) (BMNH).

SPIRIT

Mountain Pine Ridge, Privación Creek, (site B3), 17°00'N88°53'W, 2163 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♀ (reared) (BMNH). Mountain Pine Ridge, San Ignacio-Las Cuevas rd., before Guacamallo Bridge, Bailarina Camp, (site B7), 16°51'N88°59'W, 1294 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♀ (landing on man) (BMNH). Las Cuevas Research Station, Smokey River (BE96–16); 12.iv.1996, (*R. Lane*) – several pupae (BMNH). Near Las Cuevas Research Station, Logging Camp, (BE96–18), 16°33'67"N 89°05"74"W; 12.iv.1996, (*R.Lane*) – many pupae (BMNH). Mountain Pine Ridge, R. Frio Cave, (site B10) 16°59'N88°00'W, 1430 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♀ (reared) (BMNH). Mountain Pine Ridge, Paddy Creek, (site B14), 16°56'N89°00'W, 1455 ft.; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 3 ♂♂ (reared), 1 pupa (BMNH). Chiquibul Forest area, Monkey Trail Branch, (site B18), 17°00'N89°58'W; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 3 ♂♂ (reared) (BMNH). Augustine; 1.vii.1968, (*W.L.Hazse*) – 1 ♀ (at black light) (USNM). Las Cuevas Research Station, Smokey River, (No. BE96–16); 12.iv.1996, (*R.Lane*) – several pupae (BMNH). Near Las Cuevas Research Station, Logging Camp, (BE96–18), 16°33'67"N 89°05"74"W; 12.iv.1996, (*R.Lane*) – numerous pupae (BMNH).

Stann Creek District

PINNED

Placencia-Middlesex rd. (Southern Highway), Mayflower Creek, (site B55), 16°56'N88°22'W, 294 ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2 ♀♀ 1 ♂ (reared), 5 pupae (BMNH). Hell's Teeth; 10.ii.1958, (*P.C.C. & D.J.Lewis*) – 2 ♀♀ (BMNH).

SLIDE

Southern Highway, S. Middlesex, North Stann Creek, (site B57), 17°00'N88°28'W; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♀ (reared) (BMNH).

SPIRIT

Placencia-Middlesex rd. (Southern Highway), Silk Grass Creek, (site B54), 16°51'N88°20'W, 204 ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 4 pupae (BMNH).

Toledo District

PINNED

Blue Creek (at entrance of International Zoological Centre), (site B26), 16°12'N89°02'W, 190 ft.; 18.ii.2001, (*A.J.Shelley & L.M.Hdez*) – 2 ♀♀ (reared) (BMNH). Blue Creek-Santa Theresa rd., Aguacate Creek, (site B27), 16°08'N89°00'W, 140 ft.; 18.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♂ (reared) (BMNH). Santa Theresa-San Lucas rd., Go to Hell Creek, (site B28), 16°004'N89°06'W, 234 ft.; 18.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2 ♀♀ 1 ♂♂ (reared) (BMNH). Rd. to San Lucas, Corazón Creek (site B29), 16°03'N89°07'W, 175 ft.; 18.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 3 ♀♀ 4 ♂♂ (reared) (BMNH). Rd. to San Lucas, first creek (un-named) after Corazón Creek, (site B30), 16°00'N89°09'W, 207 ft.; 18.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2 ♀♀ (reared) (BMNH). Otoxha Village, R. Temash, (site B31), 16°00'N89°11'W, 200 ft.; 18.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♀ 2 ♂♂ (reared) (BMNH). Jalacte-Santa Elena-Pueblos rd., Jalacte Creek, (site B33), 16°11'N89°11'W, 430 ft.; 19.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2 ♂♂ (reared) (BMNH). Jalacte-Santa Elena-Pueblos rd., Black Creek, (site B34), 16°11'N89°10'W, 955 ft.; 19.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2 ♀♀ (reared) (BMNH).

SLIDE

Jalacte-Santa Elena-Pueblos rd., Jalacte Creek, (site B33), 16°11'N89°11'W, 430 ft.; 19.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1 ♂ (reared) (BMNH). Santa Theresa-San Lucas rd., Go to Hell Creek, (site B28), 16°004'N89°06'W, 234 ft.; 18.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 3 ♀♀ (reared) (BMNH).

SPIRIT

Punta Gorda-Manfredi-Blue Creek rd., Manfredi Creek, (site B25), 16°14'N89°59'W, 189 ft.; 17.iii.2001, (*A.J..Shelley & L.M.Hdez*) – 3 pupae (BMNH). Santa Theresa-San Lucas rd., Go to Hell Creek, (site B28), 16°004'N89°06'W, 234 ft.; 18.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2 ♀♀ (reared), 3 pu-

pae (BMNH). Rd. to San Lucas, Corazón Creek, (site B29), 16°03'N89°07'W, 175 ft.; 18.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀2♂♂ (reared) (BMNH). Rd. to San Lucas, first creek (un-named) after Corazón Creek, (site B30), 16°00'N89°09'W, 207 ft.; 18.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀1♂ (reared) (BMNH). Otoxha Village, R. Temash, (site B31), 16°00'N89°11'W, 200 ft.; 18.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀1♂ (reared) (BMNH). Southern Highway, Medina Bank Creek, (site B38), 16°26'N88°24'W, 113 ft.; 20.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 3♀♀2♂♂ (reared) (BMNH).

There is a total of 40 slides, most of them collected, prepared and identified by D.J.Lewis as *S. samboni*. Many of the slides contain more than one specimen and many of the specimens could not be identified without remounting. Slides where Lewis' s identification has been confirmed are marked with the stage of the specimen(s) and L.M.Hdez. The following localities are registered where the identifications have been confirmed: **Cayo District**: San Antonio; 21.i., 28.i.1986; (*D.J.Lewis*). San Antonio area; 19–29.i., 22.ii.1966, (*R.H.L.Disney*). Privación Creek; 31.i.1958, (*P.C.C.Garham & D.L.Lewis*). Augustine area; 24.x.1964, (*R.H.L.*). Dry Creek; 10.ii.1958, (*P.C.C.Garham & D.L.Lewis*). Rio Frio; 5.ii.1958, (*P.C.C.Garham & D.L.Lewis*). Rio On; 5.ii.1958; (*D.L.Lewis & P.C.C.Garham*). **Stann Creek**: Hell's Teeth; 10.ii., 15.ii.1958, (*D.L.Lewis & P.C.C.Garham*). Middlesex; 7.ii.1958, (*P.C.C.Garham & D.L.Lewis*).

HONDURAS

Cortés Department

SLIDE

250 m from treatment point, pt. 24 hrs. post tr.; 24.iii.1984, (*L.A.Lacey*) – 1♂ (BMNH).

SPIRIT

250 m from treatment point, pt. 24 hrs. post tr.; 24.iii.1984, (*L.A.Lacey*) – 2♀♀, 8 pupae (BMNH).

MEXICO

Chiapas State

PINNED

El Rosario; 18.vii.1942, (*A.Díaz N.*) – 1♀ (BMNH, B.M.1949–236). Hannover; 12.vii.1942, (*A.Díaz N.*) – 1♀ (BMNH, B.M.1949–236).

Veracruz State

PINNED

Canaleta; xii.1948, (*F.Reyer*) – 1♀1♂ (BMNH).

PANAMA

PINNED

Canal Zone, junction of rds. K6 and K9, Rio Cocoli; 1–6.vii.1985, (*A.J.Shelley*) – 7♀♀17♂♂ (reared) (BMNH). Canal Zone, between canal and Empire Range on K2, R. Comacho; 1–6.vii.1985, (*A.J.Shelley*) – 3♀♀2♂♂ (reared) (BMNH).

SLIDE

Canal Zone, junction of rds. k6 and k9, Rio Cocoli; 1–6.vii.1985, (*A.J.Shelley*) – 1♀1♂, 3♀♀1♂ (reared) (BMNH).

SPIRIT

Quebrada, Mañanita; 14.i.1940, (*R.P.*) – several pupae and exuviae (BMNH-Ex. London School of Hygiene and Tropical Medicine). Canal Zone, Summit Gardens, stream in garden, (site P8); 1–6.vii.1985, (*A.J.Shelley*) – 1♂ (reared), several pupae (BMNH). Canal Zone, nr. Gatuncillo, R. Limón; 1–6.vii.1985, (*A.J.Shelley*) – 3♂♂ (reared), 4 pupae (BMNH). Canal Zone, junction of rds. K6 and K9, Rio Cocoli; 1–6.vii.1985, (*A.J.Shelley*) – 1♀3♂♂ (reared), numerous pupae (BMNH). Canal Zone, between Canal and Empire Range on K2, R. comacho; 1–6.vii.1985, (*A.J.Shelley*) – numerous pupae

Coclé Province

SPIRIT

El Valle, La Mapolo, R. Antón, (site P1), 680 m; 1–6.vii.1985, (*A.J.Shelley*) – 1♀ (reared) (BMNH). El Valle, Rio Antón, 560 m; 1–6.vii.1985, (*A.J.Shelley*) – 2♂♂ (reared), numerous pupae (BMNH).

VENEZUELA

PINNED

Altagracia, Quebrada Caramacare; 28.vi.1961, (*D.L.Lewis*) – 6♀♀5♂♂ (BMNH, B.M.1962–380). Guanabara; 5.iv.1961, (*D.L.Lewis*) – 5♀♀13♂♂ (BMNH, B.M.1962–380). El Salto; 26.iv.1961, (*D.L.Lewis*) – 3♀♀4♂♂ (BMNH, B.M.1962–380). Rio Colorado; 6.v.1961, (*D.L.Lewis*) – 4♀♀2♂♂ (BMNH, B.M.1962–380). Altamira; 16.vi.1961, (*D.L.Lewis*) – 1♀ (BMNH, B.M.1962–380). Rio Guatatal; 5.iv.1961, (*D.L.Lewis*) – 1♀2♂♂ (BMNH, B.M.1962–380). Tucuyito, Quebrada Marbellaco; 14.vi.1961, (*D.L.Lewis*) – 1♀ (BMNH, B.M.1962–380). San Rafael, Edo. Portugesa; (no date), (*Jaime Ramírez*) – 2♀♀1♂ (reared) (BMNH, B.M.1969–676). Agua Blanca, Edo. Portugesa; (no date), (*Jaime Ramírez*) – 2♀♀ (reared) (BMNH) – 1♀ (reared) (BMNH, B.M.1969–676). Guarico, San Juan de Morros; (no date), (*Jaime Ramírez*) – 1♀ (BMNH, B.M.1969–676). Barina, 80 km fr de Barina, Rio Socopo; (no date), (*Jaime Ramírez*) – 1♀ (reared) (BMNH) – (BMNH).

Miranda State

PINNED

Curapao, Guarena; (no date), (*Jaime Ramírez*) – 1♀1♂ (reared) (BMNH, B.M.1969–676).

Monagas State

PINNED

San Antonio; (no date), (*Jaime Ramírez*) – 1♂ (reared) (BMNH).

There is a total of 10 slides collected, prepared and identified by D.J.Lewis and labelled 'Sp. E'. Many of the slides contain more than one specimen and many of the specimens could not be identified without remounting. The following localities are recorded from these slides: Rio Guatatal; 5.iv.1961, (*D.J.Lewis*). Altamira, (No. 1193A); 16.vi.1961, (*D.L.Lewis*). Quebrada Marbellaco, (No. 1218); 14.vi.1961, (*D.L.Lewis*). Quebrada Caramacare, (No. 1286, 9; 1292, 8; 1304, 1307); 28.vi.1961, (*D.L.Lewis*). Guanabara, (Nos. 4, 7); 5.iv.1961, (*D.L.Lewis*).

Simulium (*Simulium*) *metallicum* Bellardi (complex)

TYPE MATERIAL

MEXICO

PINNED

Mexico; 1856, (*Sallé*) – ♀ [HOLOTYPE] (MNHN) [as Museo zoologico di Parigi]. [New designation, see taxonomic discussion].

as *S. riveti* **Roubaud**

ECUADOR
Napo province

PINNED

Equateur, Napo; 1902, (*G. Riveti*) – 1♀ [HOLOTYPE] (MNHN) [a label 'in the hand of Roubaud '*Simulium riveti*, (*E. Roubaud*)'. [no date cited], 1902, (*G.Rivet*) – 5♀♀ [PARATYPES] (MNHN), 1♀ [PARATYPE] (BMNH).

SLIDE

[no date], 1902, (*G.Rivet*) – 1♀ [PARATYPE] (MNHN).

OTHER MATERIAL

BELIZE
Cayo District

PINNED

Mountain Pine Ridge, Rd to San Luis, small stream (un-named), (site B2), 16°54'N88°54'W, 2260 ft., 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (man-biting) (BMNH). Mountain Pine Ridge, Privación Creek, (site B3), 17°00'N88°53'W, 2163 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 5♀♀2♂♂ (reared) (BMNH). Chiquibul Forest area, nr. Las Cuevas Research Station, Grano de Oro, (site B5), 16°40'N89°01'W, 1874 ft.; 9–10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 16♀♀ (man-biting) (BMNH). Las Cuevas Research Station; ii.1996, (*R.Lane*) – 20♀♀(man-biting) (BMNH). Chiquibul Forest area, Natural Arch, nr. Arabato Camp, R. Chiquibul, (site B6), 16°37'N89°02'W, 1798 ft.; 9.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 7♀♀ (man-biting) (BMNH) – 3♀♀ (man-biting) 1♂ (BMNH). Mountain Pine Ridge, Blancaneaux Lodge, small stream into Privación Creek, (site B17), 17°02'N88°57'W, 1530 ft.; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 3♀♀(man-biting) (BMNH). Rio Pinol; 31.i.1958, (*D.J.Lewis*) – 1♀ (man-biting) (BMNH). Little Vaqueros Creek; 2.xi.1958, (*P.C.C.Garnham & D.J.Lewis*) – 2♀♀ (man-biting), 2♂♂ (pupae missing). Mountain Pine Ridge, Hidden Valley, 1000 Ft Falls, 17°03'N88°50'W; 8.iii.2001, (*A.J.Shelley & L.M.Hernández*) – 1♀ (man-biting) (BMNH). Chiquibul road Tower: ground; 30.i.1967, (*D.S.Bertram*) – 3♀♀ (man-biting) (BMNH-ex. London School of Tropical Medicine & Hygiene). Augustine (Douglas Da Silva); 27.vii.1961, (*D.J.Lewis*) – numerous ♀♀ (biting mule) (BMNH). Fairweather Creek; 10.ii.1958, (*D.J.Lewis*) – numerous ♀♀ (man-biting) (BMNH, B.M.1963–38).

SLIDE

Mountain Pine Ridge, Privación Creek, (site B3), 17°00'N88°53'W, 2163 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 9♀♀2♂♂ (reared) (BMNH). Mountain Pine Ridge, San Ignacio-Las Cuevas Rd, before Guacamallo Bridge, Bailarina Camp, (site B7), 16°51'N88°59'W, 1294 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 11♀♀ (man-biting) (BMNH). Mountain Pine Ridge, small stream (un-named) before Bailarina Camp, (site B8), 16°51'N88°59'W, 1376 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (reared) (BMNH). Chiquibul Forest area, Zaden Creek (Millonario), (site B11), 16°53'N89°00'W; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 3♀♀3♂♂ (reared) (BMNH). Mountain Pine Ridge, Blancaneaux Lodge, small stream into Privación Creek, (site B17), 17°02'N88°57'W, 1530 ft.; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2♀♀ (reared) (BMNH). Chiquibul Forest area, Monkey Trail Branch, (site B18), 17°00'N89°58'W; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 9♀♀(man-biting) (BMNH).

SPIRIT

Mountain Pine Ridge, Guacamallo Bridge, R. Macal, (site B1), 16°51'N89°02'W, 1209 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2♀♀(man-biting),1 pupa (BMNH). Mountain Pine Ridge, rd. to San Luis, small stream (un-named), (site B2), 16°54'N88°54'W, 2260 ft., 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 20♀♀ (man-biting), 3 pupae, 3 cocoons (BMNH). Mountain Pine Ridge, Privación Creek, (site B3), 17°00'N88°53'W, 2163 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀(man-biting), 1♀2♂♂ (reared) (BMNH). Chiquibul Forest area, Las Cuevas Research Station, (site B4), 16°44'N88°59'W, 1640 ft.; 8.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 10♀♀ (man-biting) (BMNH). Chiquibul Forest area, nr. Las Cuevas Research Station, Grano de Oro, (site B5), 16°40'N89°01'W, 1874 ft.; 9.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 15♀♀(man-biting) (BMNH). Grano de Oro; 18.vii.2002, (*M. Penn*) – 1♀ (man-biting) (BMNH). Chiquibul Forest area, Natural Arch, nr. Arabato Camp, R. Chiquibul, (site B6), 16°37'N89°02'W, 1798 ft.; 9.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 15♀♀(man-biting) (BMNH). Mountain Pine Ridge, San Ignacio-Las Cuevas rd., before Guacamallo Bridge, Bailarina Camp, (site B7), 16°51'N88°59'W, 1294 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 23♀♀(man-biting) (BMNH). Mountain Pine Ridge, Chalillo (proposed dam), R. Macal, (site B9), 16°51'N88°00'W, 1286 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2♀♀(man-biting) (BMNH). Mountain Pine Ridge, R. Frio Cave, (site B10) 16°59'N88°00'W, 1430 ft.; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 5♀♀ (man-biting) (BMNH). Chiquibul Forest area, Zaden Creek (Millonario), (site B11), 16°53'N89°00'W; 10.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2♀♀ (reared) (BMNH). Mountain Pine Ridge, Mahogany Creek, (site B12), 16°55'N89°00'W; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀(man-biting) (BMNH). Mountain Pine Ridge, Blancaneaux Lodge (dam), (site B16), 17°02'N88°57'W, 1530 ft; 11.iii.2001, (*A.Shelley & L.M.Hdez*) – 1♀ (man-biting) (BMNH). Mountain Pine Ridge, Blancaneaux Lodge, small stream into Privación Creek, (site B17), 17°02'N88°57'W, 1530 ft.; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (reared) (BMNH). Chiquibul Forest area, Monkey Trail Branch, (site B18), 17°00'N89°58'W; 11.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 4♀♀ (man-biting) (BMNH).

Stann Creek District

PINNED

Placencia-Middlesex rd. (Southern Highway), Mayflower Creek, (site B55), 16°56'N88°22'W, 294 ft.; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀(man-biting) (BMNH). Pomona, Ritchie's Farm; 8.xi.1958, (*P.CC.Garnham & D.J.Lewis*) – 1♀ (man-biting). Middlesex; 6.xi.1958, (*D.J.Lewis*) – numerous ♀♀ (man-biting) (BMNH, B.M.1963–38). North Branch; 10.xi.1958, (*D.J.Lewis*) – numerous ♀♀ (man-biting) (BMNH, B.M.1963–38). Hell's Teeth; 13, 15.ii.1958, (*D.J.Lewis*) – numerous ♀♀ (man-biting) (BMNH, B.M.1963–38).

SLIDE

Middlesex, (ID 2349); 3.iv.1984, (*R.A.D.*) – 2♀♀ (man-biting) (BMNH).

Toledo District

PINNED

Southern Highway, at San Pablo, R. Swasey, (site B50), 16°34'N88°32'W, 268 ft.; 24.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 2♀♀ (man-biting) (BMNH). 25 km. n.w. of Punta Gorda, Salamanca; 28.viii., 4.ix.1978, (*P.S. Broomfield*) – 1♀ (collected on secondary forest and scrub) (BMNH, B.M.1979–33).

SPIRIT

Jalacte-Santa Elena-Pueblos rd., Black Creek, (site B34), 16°11'N89°10'W, 955 ft.; 19.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♂ (reared) (BMNH). Southern Highway, San Pablo, R. Swasey, (site B50), 16°34'N88°32'W, 268 ft.; 24.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 1♀ (man-biting) (BMNH). Hummingbird Highway, Northern Stann Creek, (S. Middlesex), (site B57), 17°00'N88°28'W; 25.iii.2001, (*A.J.Shelley & L.M.Hdez*) – 24♀♀ (man-biting) (BMNH).

There is a total of 26 slides collected, prepared and identified by D.J.Lewis as *S. metallicum*. Many of the slides contain more than one specimen and many of the specimens could not be identified without remounting. Slides where Lewis' s identification has been confirmed are marked with the stage of the specimen(s) and A.J.S. The following localities are registered where the identifications have been confirmed: **Cayo District**: Rio Pinol; 31.i.1958, (*D.J.Lewis*). Mountain Pine Ridge; 3.ii.1958, (*D.J.Lewis*). Rio On; 5.ii.1958, (*D.J.Lewis & P.C.C.Garnham*). Paddy Creek; 2.i.1958, (*D.J.Lewis*). Little Vaqueros Creek, 25.i, 3.ii., 5.ii.1958, (*P.C.C.Garnham & D.J.Lewis*), (*D.J.Lewis*). Stream near Little Vaqueros Creek; 31.i., 3.ii.1958, (*D.J.Lewis & P.C.C.Garnham*), (*P.C.C.Garnham & D.J.Lewis*). San Luis; 22.i.1958, (*P.C.C.Garnham & D.J.Lewis*). San Antonio; 15.i.1958, (*D.J.Lewis & P.C.C.Garnham*). **Stann Creek District**: Hell's Teeth; 10.ii.1958, (*P.C.C.Garnham & D.J.Lewis*). Fairweather Creek; 10.ii.1958, (*P.C.C.Garnham & D.J.Lewis*). North Branch; 7.ii.1958, (*D.J.Lewis & P.C.C.Garnham*) (all BMNH).

COLOMBIA

Valle Department

PINNED

Approximately 15km east of Palmira, (No. 77.5.9); 23.iii.1977, (*I.Aroila*) – 1♀ (man-biting) (BMNH). Peñas Blancas, (No.77.2.42); 10.iii.1977, (*M.A.Tidwell*) – 1♀ (man-biting) (BMNH). Pance, (No. 77.17); 28.i.1077, (*M.A.Tidwell*) – 1♀ (man-biting) (BMNH). Donacui; 21., 22.xii.1963 (*G.P.Lee-Potter*) – 1♀ (man-biting) (BMNH); 3.ii.1977 (*M.A.Tidwell*) – several ♀♀ (BMNH). Noche de Santander, Arboledas, Siravita, La Esperanza; 23–24.vi.1986, (*B.Alexander*) – 22♀♀ (man-biting) (BMNH). Cundinamarca, Santandersito, Zoológica Santa Cruz, 180 m, 4°35'N74°18'W; 27.iii.1993, (*P.Mnñoz*) – 3♀♀3♂♂ (reared) (BMNH, B.M.1993–91). Cundinamarca, rd. from Alban to Sasaima (km 90), 2095m, 4°52'°26'W; 13.iii.1993, (*P.Mnñoz*) – 1♀ (reared) (BMNH, B.M.1993–91). Cundinamarca, Alban, Quebrada Garbanzal, 201m; 13.iii.1993, (*P.Mnñoz*) – 2♂♂ (reared) (BMNH, B.M.1993–91).

SLIDE

Pance, (No.77.15); 25.i.1977, (*M.A.Tidwell*) – 1♀ (BMNH). Pance, CBC, (No. 76.23); 7.ii.1977, (*M.A.Tidwell*) – 1♀ (BMNH).

COSTA RICA

PINNED

Orosi; 1.vi.1938, (*H.W.Kmnn*) – 1♀ (BMNH, B.M.1938–896). Potrero Grande, Rio Coto Brus; 3.vi.1993, (*T.Shepard*) – 3♀♀ (BMNH). Rincon de la Vieja, 25 km WNE of Liberia; 3.viii.1994, (*R.H.Cheke*) – 3♀♀(in car) (BMNH).

ECUADOR

Bolivar Province

PINNED

Babahoyo-Balzarpamba-Aguaranda Rd, in direction of Balzarpamba, R. Chaupiaco, (site E72); 10.vi.1984, (*A.J.Shelley & M.Arzube*) – 8♀♀ (man-biting) (BMNH). Babahoyo-Balzarpamba-Aguaranda Rd, Balzarpamba, unnamed stream, (site E75); 10.vi.1984, (*A.J.Shelley & M.Arzube*) – 1♀ (reared) (BMNH). Babahoyo-Balzarpamba-Aguaranda Rd, 1040 m, stream, (site E73); 10.vi.1984, (*A.J.Shelley & M.Arzube*) – 2♀♀ (man-biting) (BMNH).

Chimborazo Province

PINNED

Rio Bamba-Guano Rd, Los Helenes (nr. Guano), R. Guano, 2500 m; 12.vi.1984, (*A.J.Shelley & M.Arzube*) – 8♀♀ (man-biting), 3♀♀ (reared) (BMNH).

Cotopoxi Province

PINNED

Quevedo-La Maná-Pilaló Rd, upwards from La Mana, La Germania, Riachuelo; 9.vi.1984, (*A.J.Shelley & M.Arzube*) – 1♀ (man-biting) (BMNH).

Imbabura Province

PINNED

17 km S. of Juncal, on Ibarra road, Engeno Tababuela, R. Chota; 7.ix.1983, (*A.J.Shelley & M.Arzube*) – 7♀♀ (man-

biting) (BMNH). Salinas Rd, 20 km N. Ibarra, over bridge, R. Tahuando; 8.ix.1983, (*A.J.Shelley & M.Arzube*) – 13♀♀ (man-biting) (BMNH). Cascade into R. Tahuando; 8.ix.1983, (*A.J.Shelley & M.Arzube*) – 2♀♀1♂ (reared) (BMNH). Salinas-Lita Rd, 45 km from Ibarra, San Juan del Hacha, R. Mira; 11.ix.1983 (*A.J.Shelley & M.Arzube*) – 1♀ (man-biting) (BMNH). Salinas-Lita rd., Palacara River; 9.ix.1983, (*A.J.Shelley & M.Arzube*) – 2♀♀ (man-biting), 1♂ (reared) (BMNH). Salinas-Lita Rd, 30 km from Ibarra, small stream flowing, R. Salado; 11.ix.1983, (*A.J.Shelley & M.Arzube*) – 1♀1♂ (reared) (BMNH). Otovalo-Ibarra Rd, opp. turn of to Cotacachi, un-named stream, (site E23); 10.ix.1983, (*A.J.Shelley & M.Arzube*) – 1♂ (reared) (BMNH).

SLIDE
Salinas Rd, 20km N. Ibarra, bridge over R. Tahuando, (site E16); 8.ix.1983, (*A.J.Shelley & M.Arzube*) – 2♀♀ (man–biting) (BMNH).

SPIRIT
15 km S. Juncal, on Ibarra Rd, R. Chota, bridge at El Angel, (site E14); 7.ix.1983, (*A.J.Shelley & M.Arzube*) – numerous ♀♀ (man-biting) (BMNH). Otovolo-Ibarra Rd, opp. turn off to Cotacachi, un-named stream, (site E23); 10.ix.1983, (*A.J.Shelley & M.Arzube*) – 1♂ (reared), several pupae (BMNH). Salinas to Lita rd, 30km from Ibarra, small stream flowing into Rio Salado, (site E25); 11.ix.1983, (*A.J.Shelley & M.Arzube*) – 2♂♂ (reared), numerous pupae (BMNH). 17 km from S. of Juncal on Ibarra Rd, Ingenio Tababuela, (site E15); 7.ix.1983, (*A.J.Shelley & M.Arzube*) – numerous ♀♀ (man-biting) (BMNH). Salinas Rd, 20km N. of Ibarra, bridge over R. Tahuando, (site E16); 8.ix.1983, (*A.J.Shelley & M.Arzube*) – numerous ♀♀ (man-biting). Juncal, River Chota, (site E13); vii.ix.1983, (*A.J.Shelley & M.Arzube*) – 1♀ (man-biting). Near Salinas, Hacienda La Condal, irrigation canal (site E17), 1600 m; 8.ix.1983, (*A.J.Shelley & M.Arzube*) – 1 pupa (BMNH). 3km from Ibarra, on the Tulcan rd to Salinas, near La Hacienda La Rosa, (site E19); 9.ix.1983, (*A.J.Shelley & M.Arzube*) – numerous ♀♀ (man-biting) (BMNH). Otovalo; 12.xi.1986, (*P.B.Garwood*) – 3♀♀ (man-biting), several pupae (BMNH). Salinas-Lita Rd, Palacara River, (site E22); 9.i.1983, (*A.J.Shelley & M.Arzube*) – 3♀♀ (man-biting) (BMNH).

Loja Province

PINNED
Machala-Zaruma-Loja rd., 1300 m; 22.vi.1984, (*A.J.Shelley & M.Arzube*) – 1♀ (man-biting) (BMNH). Loja-La Toma rd., Hacienda Monterey, Rio Guayabal; 23.vi.1984, (*A.J.Shelley & M.Arzube*) – 1♀ (man-biting) (BMNH). Vilcabamba-Malacatu rd., 100 m above afluente, R. Malacatu, Estero Mangosa; 24.vi.1984, (*A.J.Shelley & M.Arzube*) – 1♀ (man-biting) (BMNH).

Los Rios Province

PINNED
Babahoyo-Montalvo rd., Rio Cristal, Madeira Bridge, 800 m; 20.vi.1984, (*A.J.Shelley & M.Arzube*) – 1♀ (man-biting) (BMNH).

Pichincha Province

SLIDE
Quito, Santo Domingo road, 640 m, Riachuelo Lelia, (site E62); 29.ix.1983, (*A.J.Shelley & M.Arzube*) – 2♀♀ (man-biting) (BMNH).

SPIRIT
Quito, Santo Domingo road, 640 m, Riachuelo Lelia, (site E62); 29.ix.1983, (*A.J.Shelley & M.Arzube*) – 9♀♀ (man-biting) (BMNH). Quito, Santo Domingo road, 640 m, Riachuelo Lelia, trickle of water on road next to Riachuelo Lelia, 640 m, (site E63); 29.ix.1983, (*A.J.Shelley & M.Arzube*) – 3♀♀ (man-biting) (BMNH).

Tungurahua Province

PINNED
Shell-Mera-Baños Rd, stream at Los Angeles, (site E193), 1210 m; 11.vi.1985, (*A.J.Shelley & M.Arzube*) – 32♀♀ (man-biting), 1♂ (BMNH). Shell-Mera-Baños Rd, stream at 1340 m, (site E196); 11.vi.1985, (*A.J.Shelley & M.Arzube*) – 5♀♀ (man-biting) (BMNH).

SPIRIT
Shell-Mera-Baños Rd, stream at Los Angeles, (site E193), 1210 m; 11.vi.1985, (*A.J.Shelley & M.Arzube*) – numerous ♀♀ (man-biting) (BMNH). Shell-Mera-Baños rd., Riachuelo Casauco, (site E194); 11.vi.1985, (*A.J.Shelley & M.Arzube*) – 3♀♀ (man-biting) (BMNH).

Zamora-Chinchipe Province

PINNED
Loja-Zamora Rd, 1km from Zamora, R. Zamora, (site 138), 160 m; 25.vi.1985, (*A.J.Shelley & M.Arzube*) – 4♀♀ (man-biting) (BMNH).

GUATEMALA
Chimaltenango Department

PINNED
Panacal, Acatenango, Chimaltenango, Gaute; 22.vi.1949 (*H.T.Dalmat*) – 2♀♀2♂♂ (pupa missing) (BMNH). Kiyá, Chalalabal, Acatenango, Chimalat'go; 3.vi. 1949, (*H.T.Dalmat*) – 1♀ (BMNH). Finca Santa Anita; 6.iii.1974, (*R.Garms*) – 3♀♀ (man-biting). S. Tomás, Escuintla; (no date), (*D. Guiaquinto*) – 3♀♀ (BMNH, B.M.1957–284). Finca Hamburg; [no date], (*D. Guiaquinto*) – 2♀♀ (BMNH, B.M.1957–284). P. Barrios; ii.1935, (*D. Guiaquinto*) – 2♀♀ (BMNH, B.M.– 1957–284).

SPIRIT
Yepocapa; 1965, (*B.O.L.Duke*) – numerous ♀♀ (man-biting) (BMNH). Finca Santa Anita; 1.xii.1974, (*R.Garms*) – various ♀♀ (man-biting) (BMNH). El Brote; 8.ii.1997 (*J.B.Davies*) – several ♀♀ [from human bait and car windscreen] (BMNH).

Guatemala Department

SLIDE
Municipio Via Canales, Finca El Rincón; 10.xi.1987, (*W.S.Procunier*) – 2♂♂ (reared) (BMNH).

HONDURAS
Cortés Department

SPIRIT
El Cacao, small stream; 23.ii.1984, (*L.Lacey*) – several pupae (BMNH). El Cacao, small stream, near Potrerillos; 23.iii.1984, (*L.Lacey*) – 3 pupae (BMNH).

MEXICO
Chiapas State

PINNED
Acacoyagua, Golondrinas; 22.i.1987, (*A.L.Millest*) – 12♀♀ (man-biting), 1♂ (reared) (BMNH). Pantelhó; 9.xi.1987, (*A.L.Millest*) – 5♀♀1♂ (pupa missing) (BMNH). Escuintla, Xalapa; 24.i.1987, (*A.L.Millest*) – 6♀♀ (man-biting), 1♀1♂ (reared) (BMNH). Huixtla, Morelos; 30.v.1987, (*A.L.Millest*) – 2♀♀ (man-biting). Huixtla, Morelos, Loma Bonita 3; 25.vi.1987, (*A.L.Millest*) – 1♂ (reared) (BMNH). Tapachula, Chespal, near NE2; 18.vii.1987, (*A.L.Millest*) – 1♀ (man-biting) (BMNH). Simojovel; 5.xi.1987, (*A.L.Millest*) – 2♀♀ 1♂ (reared, pupa missing), 1♂ (reared) (BMNH). Tuzantan, San Cristobal 4; 8.ii.1987, (*A.L.Millest*) – 1♀ (reared) (BMNH). Chiapas, Musté; 18.i.1945, (*Vargas & Dias*) – 2♀♀1♂ (BMNH).

SLIDE
Soconusco, Morelos; 22.xi.1979, (*C.McKenzie*) – 3♀♀ (man-biting) (BMNH).

SPIRIT
Soconusco, Morelos; 22.xi.1979, (*C.McKenzie*) – numerous ♀♀ (man-biting) (BMNH). Villanueva; 22.vii.1944, (*A.Diaz N.*) – 14♀♀6♂♂, 13 pupae (BMNH-Ex. London School of Hygiene and Tropical Medicine).

Chihuahua State

PINNED
Arroyo de los Nogales; 1925, (*C.H.T.Towsend*) – 1♀ (BMNH, B.M.1925–330).

Federal District

PINNED
Necaxa Power Station; xi.1925, (Major *A.D. Fraser*) – 3♀♀ (man-biting) (BMNH). Mexico City; 1925, (Major *A.D. Fraser*) – 1♀ (man-biting) (BMNH). Puebla Valley, Miss Evans Hacienda; xi.1925 (Major *A.D.Fraser*) – 2♀♀ (man-biting) (BMNH). West of Toluca, Valley Bravo; xii.1925, (Major *A.D.Fraser*) – 3♀♀ (man-biting) (BMNH).

Oaxaca State

PINNED
Juquila, Vijanos, S. Isidro Reforma 1; 25.x.1987, (*A.L.Millest*) – 3 ♂♂ (reared), 1 pupa male (adult missing) (BMNH). Comaltepes, La Esperanza 1; 19.x.1987, (*A.L.Millest*) – 1♂ (reared) (BMNH). San Juan Yaí, Santiago Yagollo 4; 24.x.1987, (*A.L.Millest*) – 1♂ (reared) (BMNH).

San Luis Potosí State

SPIRIT
Tamazunchales, S.L.P.; vii.1944, (*M.Macias*) – 2♀♀2♂♂ (reared), pupae (BMNH, B.M.1948–401).

PANAMA
Chiriqui Province

PINNED
Boquete 8°50'N82°20'W; 5.i.1983, (*R.T.Cheke*) – 4♀♀ (in car), 2♀♀ (man-biting) (BMNH, B.M.1991–83). Fortuna, Arroyo 45, Patizal; 22.i.1981, (*J.L.Petersen*) – 2 ♀♀ (man-biting) (BMNH). Fortuna, Quebrada Dos, Sitio Dos, (No. 0016); 24.iv.1980, (*J.L.Petersen*) – 4 ♀♀ (man-biting) (BMNH). Fortuna, Quebrada 3, (E12); 20.iii.1980, (*J.L.Petersen*) – 1♀ (reared) (BMNH). Cerro Punta, stream 2 km E. of 2100 m; 28.vii.1970, B.M.1979–125 (*P.S. Crauston*) – 6♀♀ (man-biting) (BMNH).

SPIRIT
Canal Zone, near river Gatuncillo, R. Limón, (site P9); 1–6.vii.1985, (*A.J.Shelley*) – 1♀ (reared), 2 pupae (BMNH). Boquete 8°50'N82°20'W; 5.i.1983, (*R.T.Cheke*) – several ♀♀ (man-biting) (BMNH). Canal Zone, Summit Gardens, stream in gardern; 1–6.vii.1985, (*A.J.Shelley*) – 3 pupae skins (BMNH). Chiriqui, Fortuna, Los Planes de Hornito, (No. 3857); 6.x.1985, (*J.Petersen*) – several pupae (BMNH).

TRINIDAD

PINNED
Mountain Harris; 23–31.vii.1924, (*C.L.Whithycombe*) – 2♀♀ (BMNH). Port of Spain, 5.ii.1912, (*G.A.K.Marshall*) – 6♀♀ (BMNH, B.M.1912–58). Arima; (no date), 1933, (*J. Buckley*) – 4♀♀ (BMNH, B.M. 2949–76). Trinidad, WI; (no date), (*F.W.Urich*) – 1♀ (BMNH-Ex. Coll. A.W.J.Pomeroy, B.M.1948–33). Blanchisseuse Rd, at summit; 31.x.1937, (*J. Suart*) – 12♀♀ (swept roaside) (BMNH, B.M.1937–778). Verdant; 31.xii.1913, (*F.W.Urich*) – 7♀♀ (BMNH). Aripo; 18.ix.30, (*I.G.Myers*). Trinidad, W.I.; 22.x. & 27.ix.1968, (*J.B.Davies*) – 2♂♂ (BMNH-Ex. London School of Hygiene and Tropical Medicine, B.M.1995–264).

VENEZUELA
Carabobo State

PINNED
Nr. Valencia, Tukuyito area; 14.xi.1961, (*D.J.Lewis*) – 10 ♀♀ (man-biting) (BMNH, B.M.1962–380).

Cojedes State

PINNED
Altamira; 3.vi.1961, (*D.J.Lewis*) – numerous ♀♀ (man-biting) (BMNH); 3.vi.1961, (*D.J.Lewis*) – 2 ♂♂ (reared, pupae missing) (BMNH).

Mérida State

PINNED
Mérida; i.1960, (*M. Giaquinto*) – 2♀♀ (man-biting) (BMNH, B.M.1962–380). Bailadores, 1650 m, 2200 m; (no date), (*Ramírez J.*) – 5♀♀3♂♂ (reared) (BMNH).

Miranda State

PINNED
Guarenas; 1948, (*O.R.Iriarte*) – 2♀♀ (man-biting). Estado Miranda, 300 m; no date); 1949, (*O.R.Iriarte*) – 2♀♀ (BMNH, B.M.1969–137).

Monagas State

PINNED
El Quebracho (nr. Caripe); 8.iv.1961, (*D.J.Lewis*) – numerous ♀♀ (man-biting) (BMNH). El Quebracho; 8.iv.1961, (*D.J.Lewis*) – 5♀♀ (man-biting), 9♂♂ (BMNH, B.M.1962–380). Guanaguana (nr. Caripe); 5.iv.1961, (*D.J.Lewis*) – 3♀♀ (man-biting). Caripe Area; 4.iv.1961, 5.iv.1961, (*D.J.Lewis*) – numerous ♀♀ (man-biting) (BMNH). Caripe Area, El Maro; 8.iv.1961, (*D.J.Lewis*) – 9 ♀♀ (man-biting) (BMNH, B.M.1962–380). San Antonio, Caripe Area; 6.iv.1961, (*D.J.Lewis*) – 1♀ (man-biting) (BMNH, B.M.1962–380). San Antonio, Caripe Area, La Pumerosa; 24.v.1961, (*D.J.Lewis*) – 1♀ (man-biting) (BMNH, B.M.1962–380). Caripe Area, El Caliche; 18.v, 25.v., 27.v.1961, (*D.J. Lewis*) – 1♀5♂♂ (pupae missing). Caripe Area; 5.ix.1961, (*D.J.Lewis*) – 1♂ (pupa missing) (BMNH, B.M.1962–380).

SLIDE
El Quebracho (nr. Caripe); 7.v.1961, (*D.J.Lewis*) – 2♀♀ (BMNH).

SPIRIT
El Quebracho (nr. Caripe); 7.v.1961, (*D.J.Lewis*) – numerous ♀♀ (BMNH).

There is a total of 15 slides collected, prepared and identified by *D.J.Lewis* as *S. metallicum*. Many of the slides contain more than one specimen and many of the specimens could not be identified without remounting. Slides where Lewis' s identification has been confirmed are marked with the stage of the specimen(s) and A.J.S. The following localities are registered where identifications have been confirmed: El Caliche La Curta, (No.1172); 18., 27.v.1961, (*D.J.Lewis*). La Pumerosa, El Cupei; 11.v.1961, (*D.J.Lewis*). Mérida; i.1961, (*D.J.Lewis*). San Casimiro; 9.xi.1959, (*D.J.Lewis*). [Locality illegible]; 21.iv.1961, (*D.J.Lewis*) (all BMNH).

OTHER SPECIES EXAMINED

Simulium (*Hemicnetha*) *paynei* Vargas

ECUADOR
Imbabura Province

PINNED
15 km from S. Juncal on Ibarra rd., R. Chota (bridge); 7.ix.1983,. (*A.J.Shelley & M. Arzube*) – 1♀ (man-biting) (BMNH). Salinas-Lita rd., Palacara River; 9.ix.1983, (*A.J.Shelley & M. Arzube*) – 2♀♀1♂ (man-biting) (BMNH). Cascade into R. Tahuando; 8.ix.1983, (*M. Arzube & A.J.Shelley*) – 2♀♀8♂♂ (reared) (BMNH). 4 km from Ibarra-Tulcan rd., irrigation canal, un-named stream; 9.ix.1983, (*M.Arzube & A.J.Shelley*) – 3♀♀6♂♂ (reared) (BMNH).

SLIDE
4 km from Ibarra-Tulcan rd., irrigation canal, un-named stream; 9.ix.1983, (*M.Arzube & A.J.Shelley*) – 1 pupa (BMNH).

VENEZUELA

PINNED
El Caliche; 18.v.1961, (*D.J.Lewis*) – 1♀1♂ (BMNH).

Mérida State

PINNED
Estado Mérida; (no date), (*Jaime Ramírez Pérez*) – 1♀2♂♂ (BMNH). El Ingenio, Sur de San Diego de los Altos; (no date), (*Jaime Ramírez Perez*) – 1♀ (BMNH).

SLIDE
Estado Mérida; (no date), (*Jaime Ramírez Pérez*) – 1♂ (BMNH)

as ***Simulium mathesoni*** **Vargas**

MEXICO
Oaxaca State

SLIDE
Guelatao, Oaxaca; 9.ix, 9.xi.1948, (*B.Luna*) – ♀♂ (body parts in twelve slides) (BMNH). Oxaca, Arrollo La Represa; 6.ii.1949, (*Reyes Córdoba*) – 1 pupa (BMNH).

San Luis Potosí State

PINNED
Tenechtipa, Tamazunchales; vii.1944, (*M.Macias*) – 1♀1♂ (BMNH).

as ***Simulium acatenangoenses*** **Dalmat**

GUATEMALA
Chimaltenango Department

PINNED
Acatenango, Ladrillera, Esperanza, (No. 723–22, 13); 26.v.1949, (*H.T.Dalmat*) – 1♀1♂ (BMNH). Acatenango, R. Panacal, (Nos. 722–21, 3, 28, 34, 39; 726–2; 726–5); 17.v., 23.v., 26.v.1949, (*H.T.Dalmat*) – 2♀♀3♂♂ (BMNH). Acatenango, T. paraxaj, (No. 446–1); 20.xi.1948, (*H.T.Dalmat*) – 1♀ (BMNH). Acatenango, R. La Torre, (No. 720–17); 23.v.1949, (*H.T.Dalmat*) – 1♀ (BMNH). Acatenango, R. San Diego, (Nos. 724–5, 14, 20); 13.iv.1949, (*H.T.Dalmat*) – 1♂ (BMNH). Yepocapa, R. Pocitos, (No. 903–3); 7.xii.1948, (*H.T.Dalmat*) – 1♂ (BMNH).

SLIDE
Acatenango; 13.iv., 1949, (*H.T.Dalmat*) – 1♂ (only wing, legs and abdomen) (BMNH).

Simulium (*Hemicnetha*) *rubrithorax* Lutz

BRAZIL
Goias State

PINNED
Nr. Palmeiras, Córrego Sonhem; 5.iv.1976, (*A.J.Shelley*) – 1♀1♂ (reared) (BMNH). Córrego Banderinha; 29.ix.1975, (*A.J.Shelley*) – 1♀ (reared) (BMNH).

Minas Gerais State

PINNED
Cantagallo; viii.1904, (*F.Theobald*) – 1♀ (BMNH). Mantequeira Mts., Pedralva stream; 19–22.v.1979, (*R.W.Crosskey & A.J.Shelley*) – 2♀♀ (BMNH, B.M.1979–258).

SLIDE
Mantequeira Mts., Pedralva stream; 19–22.v.1979, (*R.W.Crosskey & A.J.Shelley*) – 1 ♀ 1 ♂ (only legs and wings) (BMNH, B.M.1979–258).

Rio de Janeiro

SLIDE
Itaguai; 21.x.1994, (*E.M.Mokrabe*) – 1 ♀ (only legs and wings) (biting donkey) (BMNH).

Roraima State

PINNED
Boa Vista-Sta Helena rd., Boca de Mata, Igarapé-Cunaen, feeder stream; 16.viii.191984, (*A.J.Shelley & A.P.A.Lima Dias*) – 1 ♀ (reared) (BMNH).

São Paulo State

PINNED
Northern Serra da Bocaina, (site 16); 15–16.v.1979, (*R.W.Crosskey & A.J.Shelley*) – 3 ♀♀ 2 ♂♂ (BMNH, B.M.1979–258). Northern of Serra da Bocaina, km 264, S.P.66; 15–16.v.1979, (*R.W.Crosskey & A.J.Shelley*) – 1 ♀ 1 ♂, 2 pupae (BMNH, B.M.1979–258).

SLIDE
Northern Serra da Bocaina, Fazenda Barra de Turvo, (site 453); 15–18.v.1979, (*R.W.Crosskey & A.J.Shelley*) – 1 ♀, 1 ♂ (reared), 2 pupae, (BMNH). Northern Serra da Bocaina, (site 460), km 264, S.P.66; 15–16.v.1979, (*R.W.Crosskey & A.J.Shelley*) – 1 ♀ 1 ♂ (BMNH, B.M.1979–258).

Simulium (*Simulium*) *horacioi* Okazawa & Onishi

TYPE MATERIAL

GUATEMALA
Department Escuintla

SPIRIT
San Vicente Pacaya, Quebrada Los Lavaderos; 1.ii.1978, (*T.Okazawa*) – ♀ with pupal exuviae [HOLOTYPE], 1 ♀ 2 ♂♂ with exuviae [PARATYPES, one reared ♂ as ALLOTYPE] (NSMT).

Simulium (*Simulium*) *jobbinsi* Vargas, Martínez Palacios & Díaz Nájera

TYPE MATERIAL

MEXICO
Chiapas State

SLIDE
El Naranjo; 19–21.xii.1944, (*J.Parra*) – ♂ [HOLOTYPE, 3820] (INDRE). El Naranjo; 19–21.xii.1944, (*J.Parra*) – 1 ♀ [PARATYPE, No. 3821 as ALLOTYPE) (INDRE).

OTHER MATERIAL

MEXICO
Chiapas State

PINNED
El Vergel, (Nos. 6378, 6384); 22.i.1945, (*A. Díaz N.*) – 1 ♂ 1 ♀ (INDRE).

SPIRIT
Moto, Berrozabal; 2.iii.1947, (*A Díaz Nájera*) – 5 pupae (3 exuviae) (INDRE)

GUATEMALA
Chimaltenago Department

PINNED
Acatenango, Finca Armenia, Rio Lojas, (No. 401.1); 2.x.1948, (*H.T.Dalmat*) – 1 ♂ (BMNH). Acatenango, Finca Quisache, Rio Pocitos, (Nos. 414.20, 414.29, 414.64, 419.9); 8.xi., 18.xi.1948, (*H.T.Dalmat*) – 1 ♀ 1 ♂ (BMNH).

SLIDE
Acatenango, Finca Quisache, Rio Pocitos, (Nos. 414–51, 414–56); 16.xi., 18.xi.1948, (*H.T.Dalmat*) – 1 ♀ 1 ♂ (BMNH).

Simulium (*Simulium*) *racenisi* Ramírez Pérez

TYPE MATERIAL

VENEZUELA
Miranda State

PINNED
Caurimare, Caracas, *Simulium* sp. 'G.' *D.J.Lewis*; [no date], [*J.Ramírez-Pérez*] – 1 ♀ [PARATYPE, genitalia on slide] (BMNH, B.M.1969–676).

OTHER MATERIAL

VENEZUELA

PINNED
El Caliche; 27.v.1961, (*D.J.Lewis*), – 2 ♀♀ (Nos. 1174, 1176) (pupa on slides labelled 1174, 1176) (BMNH, B.M.1962–380.).

SLIDE
El Caliche; 27.v.1961, (*D.J.Lewis*) – 1 ♀ (genitalia only) (BMNH, B.M.1962–380, No. 117).

There is a total of 11 slides of material collected and mounted by D.J.Lewis and labelled as '*Simulium* sp. G.' from localities near San Antonio de Maturin in the Caripe part of the northern part of the onchocerciasis focus in Venezuela. Some slides contain more than one specimen and many of the specimens could not be identified without remounting. Slides where Lewis' s identification has been confirmed are marked with the stage of the specimen(s) and A.J.S. El Caliche; 18.v., 25.v., 27.v.1961, (*D.J.Lewis*). Pumerosa, El Cupei, 580 m; 11.v.1961, (*D.J.Lewis*) (all BMNH, B.M.1962–380).

Simulium (*Psilopelmia*) *veracruzanum* Vargas, Martínez Palacios & Díaz Nájera

TYPE MATERIAL

MEXICO
Veracruz State

SLIDE

San Miguel, Fortín, (No. 420); ii.1946, (*J.Parra*) – ♂ [HOLOTYPE, No. 3780]. San Miguel, Fortín, (No. 414); ii.1946, (*J.Parra*) – 1♀ [PARATYPE, No. 3779] (INDRE).

OTHER MATERIAL

Veracruz State

PINNED

Escamela; 31.i.1948, (*F.Reyes*) – 1♀ (INDRE) [This specimen has a paratype label but was collected two years after the first description of the species. It has no type status]. Huatusco, La Cuchilla; 25.viii.1948, (*Córdoba-Reyes*) – 1♀1♂ (INDRE).

INDEX

Synonyms and misidentifications are in italics; main citations in **bold.**